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15 November 1973
SUPERSEDING
MIL-G-3087B(SHIPS)
14 October 1955
(See 6.6)

MILITARY SPECIFICATION

GENERATOR SETS, STEAM TURBINE

(DIRECT AND ALTERNATING CURRENT)

NAVAL SHIPBOARD USE

1. SCOPE

1.1 Scope. This specification covers continuous duty shipboard installed steam turbine generator sets rated up to 1000 kilowatts (kW) direct current(dc) and 300 to 2500 kW alternating current (ac).

1.2 Classification. The steam turbine generator sets shall be of the following types and classes as specified (see 6.1.1):

Type I - Package.
Type II - Nonpackage.
Class A - Dc.
Class B - Ac.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-C-104 - Crates, Wood; Lumber and Plywood Sheathed, Nailed and Bolted.
MIL-P-116 - Preservation-Packaging, Methods of.
MIL-B-131 - Barrier Material, Water Vaporproof, Flexible, Heat Sealable.
MIL-B-857 - Bolts, Nuts and Studs.
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-C-915/30 - Cable, Electrical, 1000 Volts, Type TSGU.
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-R-2729 - Regulator Set, Voltage, A.C. Generator (Naval Shipboard Use).
MIL-G-3111 - Generators, Electric, Direct-Current (Naval Shipboard Use).
MIL-G-3124 - Generator, Alternating Current, 60 Cycle (Naval Shipboard Use).
MIL-L-3150 - Lubricating Oil, Preservative, Medium.
MIL-C-5015 - Connectors, Electric, "AN" Type, General Specification for.
MIL-Q-9858 - Quality Program Requirements.
MIL-M-9868 - Microfilming of Engineering Documents, 35MM, Requirements for.
MIL-C-9959 - Container, Flexible, Reusable, Water-Vaporproof.
MIL-M-15071 - Manuals, Technical: Equipments and Systems Content Requirements for.
MIL-T-15108 - Transformers, Power, Step-Down, Single Phase, 60-Cycle, 1-KVA Approximate Minimum Rating; and Reactors (Balance Coils) - Dry, Naval Shipboard.
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-T-15377 - Temperature Monitor Equipment, Naval Shipboard.
MIL-C-15430 - Condenser, Steam, Surface: Naval Shipboard.
MIL-E-15465 - Ejector Assemblies, Air.
MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold Application.
MIL-E-16298 - Electric Machines Having Rotating Parts and Associated Repair Parts: Packaging of.
MIL-P-16789 - Preservation, Packaging, Packing and Marking of Pumps General, and Associated Repair Parts.

MILITARY (continued)

MIL-P-17286 - Propulsion and Auxiliary Steam Turbines and Gears (Including Repair Parts, Tools, Accessories and Instruments); Packaging of.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories and Repair Parts, Packaging and Packing of.
MIL-W-19088 - Wattmeters, Switchboard Type, 4-1/2 Inch.
MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative and Break-In.
MIL-G-21410 - Governing Systems, Speed and Load-Sensing (for Electric Generator Sets).
MIL-M-24365 - Maintenance Engineering Analysis: Establishment of, and Procedures and Formats for Associated Documentation, General Specification for.
MIL-T-24398 - Turbine, Steam and Reduction Gear, Auxiliary, Generator-Drive (Naval Shipboard Use).
MIL-M-38761/2 - Microfilming and Photographing of Engineering/Technical Data and Related Documents: PCAM Card Preparation, Engineering Data Micro-Reproduction System: Microfilm Aperture and Tabulating Cards for Naval Ship Systems.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
MIL-STD-470 - Maintainability Program Requirements (for Systems and Equipments).
MIL-STD-471 - Maintainability Demonstration.
MIL-STD-721 - Definitions of Effectiveness.
MIL-STD-756 - Reliability Prediction.
MIL-STD-777 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Surface Ships.
MIL-STD-785 - Requirements for Reliability Program (For Systems and Equipments).
MIL-STD-882 - System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for.
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; With Appropriate Test Methods.
MS17828 - Nut, Self-Locking, Hexagon, Regular-Height, (Nonmetallic Insert) 250°F, Nickel-Copper Alloy.
MS17829 - Nut, Self-Locking, Hexagon-Regular Height, 250°F, (Non-Metallic Insert) Non-Corrosion Resistant Steel.

HANDBOOK

MILITARY

MIL-HDBK-472 - Maintainability Prediction.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)

S1.4-1971 - Sound Level Meters.
S1.11-1971 - Octane, Half-Octane, and Third-Octane Band Filter Sets.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, N.Y. 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

E-208-1969 - Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

NATIONAL BUREAU OF STANDARDS
Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

U.S. DEPARTMENT OF AGRICULTURE
Handbook No. 252 - Wood Crate Design Manual.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC.
National Motor Freight Classification Rules

(Application for copies should be addressed to the National Motor Freight Traffic Association, Inc., 1616 P Street, N.W., Washington, D.C. 20036.)

UNIFORM CLASSIFICATION COMMITTEE.
Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Definitions. For the purpose of this specification, the definitions specified in 6.2 shall apply.

3.2 Design. The requirements specified herein are not to be considered as desirable goals but shall be considered as minimum standards.

3.2.1 The design shall have as primary objectives:

(a) Maximum reliability and maintainability.
(b) Maximum ease of operation.
(c) Best possible access for maintenance.

3.2.2 The design and construction shall be such that maintenance in service requires a minimum of precision workmanship or critical adjustments.

3.2.3 Reliability and maintainability. The contractor shall employ in the process of design and manufacture such methods as are necessary to assure achievement of levels of reliability and maintainability of the complete generator set no less than those specified in 3.2.3.2 and 3.2.3.5.

3.2.3.1 Reliability and maintainability program and plan. The contractor shall develop, submit for review, maintain and implement a reliability and maintainability program and plan using MIL-STD-785 (see 6.5) and MIL-STD-470 (see 6.5) as guides. When satisfactory to the procuring activity and where a program plan and report for similar equipment was previously submitted by the contractor and reviewed by the procuring activity, the contractor need only propose any changes considered appropriate because of dissimilar items and current intended use.

3.2.3.1.1 The reliability and maintainability program and plan shall cover as a minimum control, monitoring and conformance to 3.2.3.2 through 3.2.5. The reliability and maintainability program shall be incorporated into the contract and shall become a contractural compliance document.

3.2.3.2 The generator set shall be designed to operate satisfactorily over the following operating life. The operating life shall be not less than 150,000 hours based on conditions listed in 3.2.3.4. This life shall be predicted on 20,000 hours at rated-load, 90,000 hours at 60 percent rated-load and 40,000 hours at 40 percent rated-load. The generator set shall be designed for a minimum of 1500 starts and 1500 stops during its operating life.

3.2.3.3 The design shall be such that parts which are not classified as onboard repair parts, shall not be replaced or repaired during the specified life of the generator set except where damage is incurred due to external causes unrelated to the design.

3.2.3.4 The design shall be such as to minimize the need for replacement of parts which are in the onboard repair parts category between ships overhaul periods. Such feature shall be predicted on the following basis:

(a) Generator sets are installed and operated in accordance with the instruction contained in the technical manual.
(b) Planned maintenance actions are accomplished by ships force in accordance with figure 1.
(c) Recommended actions for examination and repair during the ships overhaul period are accomplished in accordance with the instructions in the technical manual.
(d) Generator sets are expected to operate for 15,000 hours between overhaul periods.
(e) The loads involved during operation between overhaul periods will be of the magnitude and of the percentage of operating time as specified in 3.2.3.2.

3.2.3.5 The reliability prediction of the generator set shall be based on the failure rate of parts, and the information specified in 3.2.3.1 through 3.2.3.4. The design and application of these parts shall be such that the inherent Mean-Time-Between-Failure (MTBF) of the generator set is at least 1500 hours and the Mean-Time-To-Repair (MTTR) for the generator set is no more than 6 hours assuming that repair parts are available onboard the ship. The MTBF shall be predicted using the design prediction procedure of MIL-STD-756 and using the failure rate sources specified therein. For parts where no failure rate is available, a failure rate shall be estimated and the basis for the estimate shall be stated in calculations. The derating factors used for each part and the stress levels at which each part is operating shall be stated in reliability calculations. The stress levels shall be those as determined from test insofar as practicable. In those instances where test data is not available design data shall be used.

3.2.3.6 A failure is defined as occurring when the collective or individual unit performance degrades to the point where the performance requirements of this specification cannot be met.

3.2.3.7 The maintainability of the complete generator set shall be predicted in accordance with procedure IV of MIL-HDBK-472. The failure rates used shall be those which have been determined in the reliability predictions. The maintainability prediction shall take into consideration all design changes made during the engineering design phase.

3.2.3.8 Failure modes and effects analysis. The contractor shall conduct before the design test a failure-modes and effects-analysis (FMEA). Prior to conducting the FMEA, the contractor shall prepare an FMEA selection report to describe the depth of the analysis. The content of the report shall be as specified in the contract or order and shall be submitted for contracting agency review. The analysis shall include as a minimum the critical subsystems, the accessories, controls and parts delivered under the contract, whose failure would cause the system to fail. The FMEA shall include the identification and tabulation of all ways (or modes) in which any part can fail and effect of each failure mode on the next higher assembly and on the system as a whole. The FMEA shall include, but not be limited to, the following:

(a) List of critical assemblies, subassemblies or parts which by their failure rates, contribute the most to the unreliability of the generator set.
(b) Failure modes of the assemblies, subassemblies or parts and corresponding probability of failure.
(c) Effect of each failure on the equipment and the interfacing systems, and the effect of interfaces on the equipment.
(d) Possible means of reducing probability of critical failure modes.
(e) Sufficient detail to assist in preparation of the trouble-shooting manual (see 3.12.4.6).

3.2.3.9 Maintenance engineering analysis. The manufacturer shall conduct before the design test a maintenance engineering analysis (MEA). The MEA shall be performed for each functional system, equipment, unit, assembly or subassembly which requires preventative or corrective maintenance, and the continued operation of which is essential to the successful completion of the mission itself. The MEA shall include as a minimum, the completion of worksheets IV and V of MIL-M-24365.

3.2.3.10 Reliability and maintainability (R and M) data collection and reports. The contractor shall conduct an R and M data collection, analysis and corrective action program throughout all phases of testing. Where a failure is experienced or discovered during factory examination and tests, a failure analysis as defined in MIL-STD-721 shall be provided. The program and related reports shall contain as a minimum the following elements:

(a) R and M prediction reports (see 3.2.3.5 and 3.2.3.7).
(b) FMEA report (see 3.2.3.8).
(c) MEA report (see 3.2.3.9).
(d) A documentation of all failures, corrective maintenance actions and technical problems relating to R and M.
(e) An analysis of each failure and technical problem.
(f) The determination, implementation, verification of the results of corrective action.
(g) Maintainability demonstration test report (see 4.5.22.1).

3.2.3.11 System safety program. The contractor shall develop and maintain an effective system safety program that is planned and integrated into all phases of design production and testing of the equipment. The system safety program shall provide a disciplined approach to identify hazards and prescribe corrective actions in a timely cost effective manner. The system safety program tasks shall be specified in a formal plan (system safety program plan (SSPP)). The plan shall include requirements to be imposed on each subcontractor to assure compatibility with the system safety program for the equipment. MIL-STD-882 shall be used as guidance for preparing the SSPP.

3.2.3.11.1 Safety analyses. Safety analyses are performed to identify hazardous conditions for the purpose of their elimination or control. Analyses shall be made to examine the equipment, subsystems, components and their interrelationship to include logistic support, training, maintenance and operational environments.

3.2.4 Standardization. Generator sets, other than those used for special applications, shall have power output ratings as follows. These rating are for class A, and class B generator sets based on 80 percent lagging power factor (pf).

kW ratings

Class A generator sets	Class B generator sets
300	300
500	500
750	750
1000	1000
	1500
	2000
	2500

Voltage ratings

Class A generator sets	Class B generator sets
120/240 volts (3 wire)	450 volts (3 phase, 3 wire)

3.2.5 Design for maintenance.

3.2.5.1 Accessibility. The design shall, within space limitations, provide accessibility to parts which require routine examination, maintenance or replacement in service without the need for disconnection or removal of another part or assembly other than an access panel or cover. Each access panel and cover shall be openable and closeable or reuseable and replaceable (as applicable), starting from the secured position and returning to the secured position, in no more than 0.05 hour. Time required for examination, maintenance or replacement of the part is not included. The envelope of the minimum required space around the generator set and its parts for ease of maintenance shall be shown on the outline installation drawing.

3.2.5.2 Interchangeability. All parts, including repair parts, of corresponding equipment furnished under the same contract or order or manufactured to the same drawings shall be interchangeable without the necessity of further machining, selective assembly or hand fitting of any kind (see MIL-T-24398 for exceptions pertaining to certain turbine and gear parts). Interchangeability of units and parts with those supplied on generator sets previously furnished under this specification is extremely desirable with particular reference to repair parts. Units and parts serving the same or similar, function in different place of application shall be designed to be interchangeable where feasible.

3.2.6 Generator set mounting. Except for the switchboard mounted accessories and other accessories which are specified as being detached (see 6.1.1) the following mounting requirements shall apply. Each complete generator set shall be assembled on a welded steel bedplate, and shall form a rigid self-supporting structural unit suitable for maintaining alinement of units in service during shock tests and for handling during shipment and installation onboard ship without further stiffening or bracing. Unless otherwise specified (see 6.1.1), the generator set design shall employ the principle of three point support whereby the generator set bedplate is supported by the ships foundation at three points.

3.2.7 Minimum radius of cable bend. Sufficient clearance between units on the generator set and inside the enclosures of electrical accessories or electrical units furnished with the generator set shall be provided to permit ships cabling to be connected. The location of connections and clearances shall be such that cables can be installed with the following minimum radius of bend.

Current rating amperes of circuit involved	Minimum allowable radius for cable bend (Inches)
Over 360	13.5
291 to 360	13.0
215 to 290	11.0
135 to 214	9.5
100 to 134	7.5
75 to 99	6.5
45 to 74	5.5
15 to 44	4.5
Less than 15	3.0

3.2.8 Wiring connections. Main generator power terminals shall be located as specified (see 6.1.1) and shall be installed within a dripproof protected type enclosure in accordance with MIL-E-2036 which shall be provided with cable entrance plates. All wiring required between units on the generator set bedplate shall be permanently installed at the factory. Except for main generator power terminals, all electrical items installed on units attached to the generator set bedplate, which require connections to ship's wiring, shall be wired to terminal boards suitably enclosed, dripproof protected and conveniently located. Separate connection boxes or separate enclosed compartments within a common connection box shall be provided for each of the auxiliary services requiring connection to the ship's electrical wiring such as space heaters, temperature detectors, contact making devices, governors, tachometers, lube oil pump and so forth.

3.2.9 Lifting means. Eye-bolts, lugs or holes shall be provided to permit lifting the completely assembled generator set and attached accessories as a complete package. Eye-bolts or other means for lifting the individual units shall not be depended upon for lifting the assembled generator set.

3.2.10 Short circuit requirement. With voltage regulators automatically controlling generator excitation and the generator load at any value from zero to rated load, the complete class B generator set shall be capable of withstanding, without damage to any unit, a three phase fully asymmetrical short circuit at the switchboard (assuming 25 feet of interconnecting TSGU cable in accordance with MIL-C-915/30 from each generator power terminal to switchboard) with the quantity and size of cables installed as specified (see 6.1.1). Class A generator sets shall also be capable of withstanding without damage a short circuit of the switchboard (assuming 25 feet of interconnecting cable from each generator power terminal to switchboard) with the quanity, type, and size of cables as specified (see 6.1.1). The contractor shall submit a report to NAVSEC showing summation of calculations on the anticipated short circuit torque at the generator air gap, the elastic characteristics of all rotors, the shaft loading characteristics and the short circuit torque multiplying factor. This data shall be accompanied with the manufacturer's statement that all factors have been considered in designing for this short circuit torque condition and that all units will withstand this loading without damage. Such data shall be submitted with the generator set installation drawing for review.

3.2.11 Weight, size and configuration. The maximum allowable overall dimensions, general configuration and weight (dry and operating) of the complete generator set with all attached accessories shall be as specified (see 6.1.1).

3.2.12 Shock. The grade A, hull mounted, class I, heavy-weight, type A requirements of MIL-S-901 shall apply where equipment is not required to be resiliently mounted. Where resilient mounting of equipment is required, the grade A, hull mounted, class II or III, heavy weight, type A requirements of MIL-S-901 shall apply. The basis of shock design and acceptance shall be as specified hereinafter. The generator set shall be designed so that it is capable of meeting the performance requirements of this specification when subjected to the magnitude of shock specified for static and dynamic design methods or that encountered during shock tests, as applicable.

3.2.12.1 Where equipment is capable of being tested, by reason of weight and size not exceeding the available facilities, such equipment shall be subjected to the shock tests specified in 4.5.17. The intent of this specification is to use shock testing to the maximum extent possible and use static and dynamic analysis only where testing is impractical. Accordingly, where the generator set exceeds the size and weight limitations of shock testing facilities, the generator set manufacturer may propose removing one or more units from the generator set and test these units and the remaining portion of the set or individual items.

3.2.12.2 Static and dynamic design methods. The "procedures for dynamic shock, analyses, review and acceptance" shall be followed with regard to review and acceptance of dynamic design analyses. (A copy of these procedures may be obtained from the Naval Ship Engineering Center, Steam, Gas and Diesel Generator Section, Hyattsville, Maryland). Identical procedures shall be followed with regard to static analyses. The reviewing activity is the Supervisor of Shipbuilding, New York. Reports submitted for acceptance of dynamic analysis shall include information as indicated in the "procedures for dynamic shock, analysis, review and acceptance". Reports submitted for acceptance of static analysis shall provide sufficient and detailed information, including a stress report to cover all areas for which shock stresses were calculated and the applicable yield strength for each stress reported, to permit verification of results obtained. The Supervisor of Shipbuilding, New York is available for consultation and guidance with regard to information needed to permit verification of reports covering static and dynamic design analyses. Unless otherwise specified (see 6.1.1) two copies of reports covering static or dynamic design analyses shall be submitted to the reviewing activity and three additional copies each shall be forwarded to NAVSEC for dynamic analyses and static analyses.

3.2.12.2.1 Static design method. Shock design of equipment not capable of being tested in accordance with 3.2.12.1 shall be based on the following minimum static shock factor values which apply at the bottom of mounting pads, rails, or feet, and so forth, of the generator set package and detached accessories.

	Static shock factor		
Application	Vertical	Athwartship	Fore and aft
Generator set	75	45	20

3.2.12.2.1.1 Use of static shock factor values. The equipment shall be capable of withstanding shock loads due to steady acceleration at the static shock factor values applied separately in each direction (plus or minus). Each mass element of the unit shall have an inertia load applied equal to (dm times G times g) where dm = distributed mass.

G = static shock factor value tabulated herein
g = acceleration of gravity

The resulting stresses and deflections, when added to the maximum normal operating values, shall not exceed allowable stresses or deflections.

3.2.12.2.1.2 Allowable stresses. The combination of shock and operating stresses shall not exceed the 0.2 percent offset yield strength at operating temperature. The unit loading for combined shock and operating loads on babbitted bearings shall be limited to 22,000 pounds per square inch (psi). The criteria for failure when plastic set is permissible is the effective yield strength of the material, in tension and shear, which is represented by "σ" and "τ" respectively, defined as follows:

$$\sigma = \sigma_y + F(\sigma_u - \sigma_y); \tau = 0.6\sigma$$

Where: σ_y is the 0.2 percent offset yield, elastic limit or other normal definition of material yield strength.
σ_u is the normal definition of material failure strength.

F is a factor which takes into account the efficiency with which the material in the member is utilized and is dependent on the kind of

loading and cross section of the member. The value of F is equal to the load required to completely yield the member divided by that load required to just initiate yielding minus 1. F equals zero for members in tension and where material has less than 10 percent elongation before fracture in a tension test. F equals 0.5 for a rectangular section in pure bending.

3.2.12.2.2 Dynamic design method. When specified (see 6.1.1), the manufacturer shall conduct a concurrent dynamic analysis. Items found deficient by this analysis shall be identified and corrective action proposed by the manufacturer. Design changes will be incorporated at the option of the Government. Accordingly, unless otherwise specified (see 6.1.1) the incorporation of these design changes in equipment is not the responsibility of the manufacturer.

3.2.12.3 General.

3.2.12.3.1 Where carbon steels with less than 1 percent of any one alloy is used in the generator set bedplate or subbase and in unit mounting feet or mounting brackets, bearing caps, bearing pedestals and frames and for the items covered by the note regarding nil-ductility transition temperature under the materials table of MIL-T-24398, nil-ductility transition temperatures shall not exceed plus 10°F as determined by the method described in ASTM E208-69. This requirement does not apply to plate thickness less than 5/8 inch or more than 4 inches. Subject to the acceptance of the command or agency concerned, the use of impact tests may be substituted where there is sufficient statistical data to show correlation between nil-ductility properties and impact values.

3.2.12.3.2 The generator set bedplate bolt holes provided for securing the generator set and mounting holes provided for securing detached units to the ships foundation shall be designed for use with nonfitted bolts conforming to types I, II, or III, grade 5, of MIL-B-857 and self-locking nuts conforming to MS17828 or MS17829. Bolts of higher grade are permitted. When their use is accepted by the procuring activity, where such bolts are needed, the generator set manufacturer shall forward data to the procuring activity to justify the use of such bolts along with the request for acceptance. Maximum clearance between bolt-holes and bolts shall not exceed the following:

Nominal bolt diameter	Maximum diameter of hole
3/4 inch or smaller	Nominal bolt diameter plus 1/32 inch
Larger than 3/4 inch	Nominal bolt diameter plus 1/16 inch

3.2.12.3.3 Units that are rigidly supported shall not be attached to two structures which can deflect relative to each other under shock.

3.2.12.3.4 Shock mountings to minimize shock forces imparted to equipment shall not be used.

3.2.12.4 Exceptions. The basis for shock design specified in 3.2.12 through 3.2.12.3.4 applies except in the following cases:

(a) When the equipment proposed is of identical design to one which has been previously shock tested and finally accepted by the Navy, such design shall be acceptable provided it meets all other requirements of the application.

(b) When the equipment proposed is of identical design to one which has been previously statically analyzed in accordance wtih the requirements herein or dynamically analyzed and such analysis has been finally accepted by the Navy, such design shall be acceptable provided:

(1) The mathematical model applies without change. For example, the equipment is a repeat procurement for which the ships foundation and other equipment affecting the model are dynamically the same.

(2) The equipment meets all other requirements of the application.

(c) When the equipment proposed is similar, but not identical, to a design previously shock tested or statically or dynamically analyzed and accepted by the Navy, including calculated shock factor capability in these areas, and propose to the Navy the acceptance of such design in lieu of meeting the requirement in 3.2.12.1 or 3.2.12.2.2. If NAVSHIPS/NAVSEC concurs that the similar design will provide equal or better shock capabilities in the intended application, extension of acceptance will be given. Requests for extension based on unit designs previously extended will not be considered.

(d) Previously granted exceptions to shock test which are based on static or dynamic analysis and which were granted on the basis of equipment size and weight being in excess of the capacity of former shock test machines are not applicable if the equipment is now within the capacity of existing shock test machines.

3.2.13 Inclined operation. The generator set shall be designed to operate in accordance with the performance requirements of this specification, shall maintain satisfactory lubrication and shall experience no loss of liquids (including lube oil) under the following conditions.

(a) When the generator set is permanently inclined from the normal horizontal position as much as 5 degrees on either end and 15 degrees to either side.
(b) When the generator set is momentarily inclined from the normal horizontal position as much as 10 degrees on either end and 45 degrees on either side.

3.2.13.1 The momentary inclination cycle shall be as specified (see 6.1.1).

3.2.14 Vibration resistance (environmental vibration).

3.2.14.1 The complete generator set with attached accessories and all detached accessories shall be designed to withstand the following spectrum of environmental vibration without experiencing excess vibration which can prevent the equipment from performing its normal function or lead to damage or malfunctioning of the units.

Amplitude of vibration	
Frequency range hertz	Amplitude (± mils)
5 to 15	30
16 to 25	20
26 to 33	10

3.2.14.2 Vibration tests are not required on the completely assembled generator set. Vibration tests shall be conducted on individual equipments as required by the individual equipment specification or on individual equipments as specified (see 6.1.1).

3.2.14.3 Vibration test waiver. When the individual equipment proposed is of identical design to one which has been previously vibration tested and finally accepted by the Navy, such design will be acceptable provided it meets all other requirements of the application.

3.2.15 Vibration (internally excited). Unless otherwise specified (see 6.1.1), the generator set units shall be alined and balanced so that the reading of the vibration indicator shall not exceed plus or minus 0.0005 inch as measured on the bearing caps or plus or minus 0.001 inch as measured on the rotating shafts adjacent to the bearings. These limits shall apply at no-load and at all speeds up to the speed just below the value (but not less than 107 percent of rated speed) which will actuate the overspeed trip on the turbine. These limits also apply at any load up to rated value at any speed between 80 and 105 percent of rated value and under the test conditions specified in 4.5.5. A vibration indicator, whereby vibrations of the amplitude of 0.0005 inch may be readily observed on a suitable scale, will be satisfactory as a measuring device.

3.2.16 Welding and allied processes.

3.2.16.1 Welding and allied processes shall be in accordance with MIL-STD-278.

3.2.16.2 Where MIL-STD-278 requires review of specific aspects of welding and allied processes, the reviewing activity is NAVSEC. The following procedure shall be used in obtaining reviews required by MIL-STD-278:

(a) Where shipbuilder furnished equipment is involved, the request for review along with supplementary data as required by MIL-STD-278 shall be referred to NAVSHIPS/NAVSEC via the DCAS, the cognizant procuring activity (usually the shipbuilder) and the supervisor of shipbuilding. In order to expedite review action, a copy of correspondence requesting review along with supplementary data shall be forwarded directly to NAVSEC.
(b) Where Government furnished equipment is involved, the request for review along with supplementary data shall be submitted to NAVSHIPS/NAVSEC via the procuring activity where the activity is other than NAVSHIPS. A copy of correspondence requesting review along with supplementary data shall be forwarded direct to NAVSEC. Where the procurement activity is NAVSHIPS, the request for review and supplementary data shall be forwarded direct to NAVSEC.

3.2.17 Noise.

3.2.17.1 Where special noise reduction limitations are not applicable (see 3.2.17.2), the generator set and all detached accessories shall be designed so that the airborne noise levels do not exceed the following when tested in accordance with 4.5.18.1.

Sound pressure levels in decibels (dB) (ref. 0.0002 dynes/cm^2) for Center frequencies of standard octave bands in Hz

Center frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000
Pressure level (dB)	110	110	105	100	90	85	85	85	85

3.2.17.2 Where special airborne and structureborne noise limitations are applicable for the application, details of limitations for airborne and structureborne noise, whether generator sets and detached units should be resiliently mounted, the type of resilient mount to be used and the procedure for noise tests shall be specified (see 6.1.1). The requirements shall be as specified in 3.2.17.2 and 3.2.17.2.2.

3.2.17.2.1 Where resilient mounts are used, all mounts shall be of the same type and shall have equal loading, if feasible. Flanges for mounts shall be installed so that the vertical distance between the horizontal center lines of mounts and the center-of-gravity of equipment is a minimum. Mount deflection under starting, operating and securing conditions of equipment, and under shock conditions shall be considered when determining clearances around the equipment and clearances between the mounts and surrounding structure on the equipment. Where resilient mounting is used, the following information should be submitted to the activity procuring the generator set for review.

(a) Speeds of the equipment involved.
(b) Total weight of the mounted assembly in the operating condition. The weight should include bedplate, service fluids, piping, filters and all other attached accessories.
(c) Location of the center-of-gravity of the assembly in the operating condition in three planes.
(d) The moments of inertia and products of inertia of the assembly about three mutually perpendicular axis with the origin at the assembly center-of-gravity of the mounted unit and the orientation of the axis indicated with respect to the equipment.
(e) The six natural frequencies in hertz (Hz) of the assembly in the operating condition.
(f) The type of resilient mount used and any assumptions made in calculating the natural frequencies. For mounts other than Navy types, information relative to mount natural frequency, static load deflection and transmissibility is required.

3.2.17.2.2 The following factors shall be considered by the manufacturer in the design of the generator set, as necessary, to meet the noise limitations.

(a) Precision machining of rolling, rubbing and fitted parts.
(b) Maximum effort shall be made in the production phase to minimize the amount of corrections required during the final balancing phase of the generator set.
(c) Provision shall be made for inplace balancing of rotating parts and access plates shall be provided for this inplace balancing.
(d) Sharp cutoffs and turbulance shall be avoided in air cooling systems. Ventilation ducts and housings shall be damped, as necessary to prevent flow excited vibration.
(e) Most favorable combination of the following generator design features.
    (1) Number of slots per pole pitch.
    (2) Number of slots magnetically under one pole.
    (3) Slot frequency as a function of the natural frequency of the magnetic frame.
    (4) Skewing of stator slots.
    (5) Skewing of pole tips and fairing of pole tip edges.
(f) Spring mounting of generator stator punchings.
(g) Close tolerance of generator air gap.
(h) Direct drive governor.
(i) Direct drive generator.
(j) Any other features specified (see 6.1.1).

3.2.18 Threaded parts. Threaded parts shall conform to Handbook H28.

3.2.19 Ambient temperature. The generator set complete with all attached accessories shall meet the performance requirements of this specification at any ambient temperature between 40° and 122°F.

3.2.20 Piping (oil, steam and other piping for fluids).

3.2.20.1 All piping between units of the generator set shall be provided and installed by the generator set manufacturer. All piping connections for connections to units detached from the generator set or for connections to the ships system shall be provided with flanges in accordance with MIL-STD-777. Tapered pipe threads shall not be used.

3.2.20.2 Steam and liquid piping and sump vents shall not be located where drops or sprays from leaks, condensation, splashing or fumes could cause damage to electrical equipment. Where this is impractical, adequate shielding shall be provided.

3.2.20.3 The use of tapered pipe plugs shall be limited only to essential applications due to their susceptibility of coming adrift under shock. Where unavoidable, they shall be secured by tack or seal welding.

3.2.21 Fire hazard. The design shall be such as to minimize fire hazard. The following areas shall be considered in planning location of piping and units.

(a) Oil shall not leak or spray on lagging or on hot surfaces which exceed 400°F.
(b) Locate lubricating.oil strainers and filters as remote as possible from hot surfaces.
(c) Locate sump vents so that oil laden fumes cannot be drawn into the generator windings or other electrical equipment.

3.2.22 Resistance temperature sensing elements (RTD's). In addition to thermometers required by the turbine, reduction gear and generator specifications, RTD's shall be furnished in accordance with 3.2.22.1 through 3.2.22.4.12.

3.2.22.1 RTD's shall be provided on turbine and reduction gear journal bearings, turbine and reduction gear thrust bearings, generator journal bearings, generator stator windings and for detecting the temperature of generator cooling air where totally enclosed water air-cooled generators are specified and shall be suitable for use with monitors conforming to the requirements of MIL-T-15377.

3.2.22.2 Generator air temperature. The generator air temperature RTD's shall be located so as to measure the temperature of air to and from the generator air cooler.

3.2.22.3 For generator stator winding on class B generator sets. At least size RTD's (at least two per phase) shall be provided in the stator winding. These RTD's shall be located as close as practicable to the calculated hot spot of the winding.

3.2.22.4 Journal and thrust bearings. RTD's for journal and thrust bearings shall be as specified in 3.2.22.4.1 through 3.2.22.4.10.

3.2.22.4.1 Journal bearings shall be fitted with RTD's at or near the full power load line. There shall be one RTD in each journal bearing located in the middle third of the axial length of the bearing. One shoe on each side of the thrust collar shall contain an RTD.

3.2.22.4.2 The RTD's shall conform to type IC/A of MIL-T-15377 with element wiring protruding from bottom or end at bottom (see figures 2 through 5 included herein for convenience and guidance).

3.2.22.4.3 RTD's may be located at the geometric bottom center of bearing shell if this permits interchangeability of bearings. The RTD shall be installed in accordance with figure 2 in a radial hole in the bearing shell, with the sensing tip 1/16 inch below the bearing surface and with the bottom of the RTD casing bottoming on the shoulder in hole as shown.

3.2.22.4.4 The RTD shall be fusion bonded to the surrounding bearing babbitt in accordance with proven procedures and the bearing surface shall be restored to design dimensions.

3.2.22.4.5 The two wires attached to the RTD shall be brought out through a radially drilled 0.187 inch maximum diameter hole and channeled into a groove (approximately 1/8 by 3/16 inch) connecting the radial hole with a connection block (see figure 3) recessed in bearing edge or end at, or close to, the bearing part line. An air hardening epoxy-resin shall be applied in the groove to protect the wiring. Both wires shall be soldered to the connection block (see figure 5).

3.2.22.4.6 Wiring between the bearing connection block and the casing (or bearing pedestal) wall is required to complete the circuit. This wiring shall be recessed in epoxy-resin-filled grooves, in holes, or in armored sheath to protect it against damage. This wiring shall be easily disconnected (mechanically or by melting soft solder) from the bearing connection block and shall penetrate the casing wall through a type "AN" connector in accordance with MIL-C-5015 (see figure 3).

3.2.22.4.7 The design shall provide a type "AN" connector in accordance with MIL-C-5015 in the casing (or bearing pedestal) wall to connect internal wiring with external wiring. Location of "AN" connectors shall be such as to minimize the possibility of damage to connector and cables attached thereto. All penetration points shall be oiltight if the internal surfaces of these points are subject to being submerged or splashed with oil.

3.2.22.4.8 The procedures in 3.2.22.4.2 through 3.2.22.4.7 for sleeve bearings shall generally apply for installing RTD's in pivoted shoe bearings, except that the RTD shall be installed close to the trailing edge of one lower shoe and the bearing connection block shall be recessed in the edge or end of the shoe on the pivot line.

3.2.22.4.9 When installing RTD's in thrust bearing shoes, the shoes closest to the housing joint shall be fitted with RTD's to facilitate disassembly when shoes are removed for examination and replacement. The RTD in each shoe shall be installed close to the trailing edge of the shoe and the outer diameter, and the bearing connection block shall be recessed in the edge of the shoe on the pivot line. Figure 4 shows an acceptable arrangement.

3.2.22.4.10 A caution plate shall be permanently affixed to the external top of the bearing cap warning that the RTD wires to bearings shall be disconnected before rolling out the bearing. Such warning plate shall also be installed on the generator where disassembly of the generator could result in damage to the RTD arrangement installed in the generator stator and cooling air sections.

3.2.22.4.11 All wiring from RTD's shall be brought out to a connection box or boxes as specified in 3.2.8. The external wiring from RTD's to the terminal box shall be firmly supported and protected by use of rigid or flexible conduit.

3.2.22.4.12 Unless otherwise specified (see 6.1.1), temperature monitors in accordance with MIL-T-15377 shall be furnished by the activity installing the generator set.

3.2.23 Torsional vibration. In addition to displacing torsional frequencies from other frequency (such as multiples of running frequencies) as normally practiced by the generator set manufacturer, the second critical torsional frequency for the generator set shall be below 180 Hz. The first through the fifth criticals shall be determined by tests or calculations and the associated frequencies recorded on the generator set installation drawing.

3.3 Turbine and reduction gears. Turbine and reduction gear (if reduction gear is required, see 6.1.1) shall conform to the requirements of MIL-T-24398. The following shall be specified (see 6.1.1).

(a) Type and class of turbine and gear.
(b) Normal rated steam inlet (at throttle) and exhaust conditions.
(c) Maximum and minimum steam inlet (at throttle) and exhaust conditions.
(d) Type of governor required.
(e) Steam rates.
(f) Pressure and temperature of make-up steam for the gland seal system.
(g) Mounting of gageboard, if other than specified in MIL-T-24398.

3.4 Condensers (see 6.1.1).

3.4.1 Condensers (when type I generator sets are specified) shall conform to the requirements of type II, class B, of MIL-C-15430 and the following:

(a) Condensers shall be equipped with thermometers and gages (including an 8-1/2 inch vacuum gage) of the types required by MIL-C-15430. The specific location of these thermometers and gages (whether located on right-hand

side or left-hand side of condenser, etc.) shall be as specified (see 6.1.1).
(b) The condenser shall be double-pass and shall be supplied with cooling water from independent circulating pumps to be furnished by the activity installing the generator set.
(c) The condenser and associated equipment shall be capable of maintaining the specified vacuum at the turbine exhaust with rated flow of 75°F cooling water and with the following conditions occurring simultaneously.
(1) Condenser exhaust steam from the generator turbine at the maximum rated load of the generator.
(2) Receiving generator set drains.
(3) Maximum auxiliary exhaust steam loads.

3.4.1.1 The maximum auxiliary exhaust steam exhaust flow to condenser including characteristics (pressure, temperature, enthalpy and so forth) shall be as specified (see 6.1.1).

3.4.1.2 Where air ejector assemblies are mounted on the side of the condenser, the condenser design shall permit installation on either side of the condenser.

3.4.1.3 The location of connections required by MIL-C-15430 shall be as specified (see 6.1.1). Where an auxiliary exhaust steam connection is specified (see 6.1.1), the location and size of this connection or connections shall be as specified (see 6.1.1). Where auxiliary exhaust steam connections are to be provided on each side of the condenser, each connection shall be capable of handling the auxiliary exhaust steam. Covers shall be provided for the air ejector and auxiliary exhaust steam connection not used by the installing activity.

3.5 Air ejectors (see 6.1.1). Air ejectors (where type I generator sets are specified) shall conform to the requirements of type A of MIL-E-15465 and the requirements specified in 3.5.1 through 3.5.4.

3.5.1 Assemblies shall be two stage units with inter and after condenser or two stage units with a noncondensing first stage and after condenser only as specified (see 6.1.1). The after condenser shall be designed to accept the turbine packing gland leak off-flows.

3.5.2 The ejectors shall be steam jet type and shall be designed for operation with steam under the normal pressures specified (see 6.1.1) and with maximum steam conditions as specified (see 6.1.1).

3.5.3 Air ejector assemblies shall be designed for mounting on the generator set condenser which they serve. When designed for mounting on the side of the condenser, the air ejector assemblies shall be suitable for mounting on either side of the condenser.

3.5.4 The following additonal characteristics shall be specified (see 6.1.1).

(a) Whether a gland exhaust fan will be used (to be furnished by activity installing generator set).
(b) Whether a gland ejector is to be furnished as part of the air ejector assembly.

3.6 Electrical equipment.

3.6.1 Grounding. Electrical circuits shall be ungrounded.

3.6.2 Generators.

3.6.2.1 Bearings. Bearings shall be of the sleeve type, forced feed lubricated from the turbine lubrication system. Sight flow fittings and thermometers shall be provided at the bearing oil discharge. Single bearing generator rotors shall have an integral forged flange with suitable size and configuration to bolt to the mating driver flange.

3.6.2.2 Where a class A generator set is specified, generators shall conform to the requirements of MIL-G-3111 and shall be of the following classification:

(a) Service application - Ships service.
(b) Kilowatt (kW) rating - As specified (see 6.1.1).
(c) Voltage - Voltage, two or three wire, as specified (see 6.1.1).
(d) Rpm - As specified (see 6.1.1).
(e) Enclosure - {Below 500 kW, dripproof protected. / 500 kW and larger, totally enclosed, water-air-cooled.}
(f) Ambient temperature - 40° to 122°F.
(g) Bearings - Sleeve.
(h) Insulation - Class B or F.

3.6.2.3 Where a class B generator set is specified, generators shall conform to the requirements of MIL-G-3124 and shall be of the following classification:

(a) Service application - Ships service.
(b) Type - Rotating field (salient pole or round rotor) as specified (see 6.1.1).
(c) kW rating - As specified (see 6.1.1).
(d) Voltage - As specified (see 6.1.1).
(e) Phases - 3.
(f) Frequency - 60 Hz or special, as specified (see 6.1.1).
(g) Rpm - As specified (see 6.1.1).
(h) Enclosure - {Below 500 kW, dripproof protected. / 500 kW and larger, totally enclosed, water-air-cooled.
(i) Bearings - Sleeve.
(j) Ambient temperature - 40° to 122°F.
(k) Insulation - Class B, F, H or N.

3.6.2.4 All generator frames shall have feet of ample size to accommodate holding-down bolts, dowel pins and jackscrews to insure attachment to and removal from the generator set bedplate.

3.6.3 Circuit breaker trip switch and balance coils for class A.

3.6.3.1 A governor-operated trip switch shall be furnished and mounted on the generator set. When the generator set is operating at rated speed, this switch shall be in the open position. When the generator set overspeeds, the emergency overspeed governor shall trip, thereby closing the trip switch which in turn shall open the generator circuit breaker. The switch shall conform to the following classification:

(a) Enclosure - Watertight.
(b) Voltage - As specified for the generator.
(c) Shock characteristics - Class HI as defined in MIL-S-901.
(d) Ambient temperature - 40° to 122°F.

3.6.3.2 Balance coils for three wire class A generator sets shall be furnished. These coils shall conform to MIL-T-15108 and shall be of the following classification:

(a) Enclosure - Dripproof-protected.
(b) Rating - As required by the class A generator.
(c) Duty - Continuous.
(d) Ambient temperature - 40° to 122°F.
(e) Mounting - As specified (see 6.1.1).

3.6.4 Excitation and voltage regulation equipment.

3.6.4.1 Where class A generator sets are specified the requirements specified in 3.6.4.1.1 and 3.6.4.12 shall apply.

3.6.4.1.1 The class A generator shall be of the self-excited type. Voltage regulators shall not be furnished.

3.6.4.1.2 Generator field rheostats. Generator field rheostats shall be furnished and shall have the following characteristics:

(a) Enclosure - Dripproof.
(b) Rating - As required for the generator.
(c) Duty - Continuous.
(d) Mounting - Switchboard.
(e) Ambient temperature - 40° to 122°F.
(f) Control - The rheostat shall have sufficient resistance to reduce the open circuit generator voltage to 50 percent of rated value at rated speed. In addition, with the generator operating at rated speed, the rheostat shall be capable of adjusting generator voltage in steps of not more than 0.5 percent of rated voltage between the limits of 96 to 105 percent of rated voltage and in steps of not more than 1.0 percent of rated voltage between the limits of 90 to 96 percent of rated voltage at any generator load between zero and rated value.

3.6.4.2 Where class B generator sets are specified, the requirement specified in 3.6.4.2.1 shall apply.

3.6.4.2.1 Voltage regulation systems shall be type II or type III of MIL-R-2729, as specified (see 6.1.1) and shall be of the following classification:

(a) Parallel operation - Required.
(b) Mounting for type III - As specified (see 6.1.1).
(c) Source of initial excitation power if external to generator set - As specified (see 6.1.1).

3.6.5 Governing systems.

3.6.5.1 Governors shall be of the hydraulic relay, centrifugally controlled type as required by MIL-T-24398 or the electric speed and load sensing type as required by MIL-G-21410, as specified (see 6.1.1). Parallel operation shall be required.

3.6.6 Governor speed changing device for class B generator sets.

3.6.6.1 Where the hydraulic relay, centrifugally controlled type governor is furnished, it shall include an electric motor drive to allow control of generator set speed from remote locations.

3.6.6.2 Where an electric speed and load sensing governor is furnished and control of generator set speed is required from more than one remote station, in addition to furnishing a manually operated potentiometer for speed control from one station, electric motor driven potentiometer shall be furnished for control of speed from other remote stations in the quantity as specified (see 6.1.1).

3.6.6.3 Electric motors specified in 3.6.6.1 and 3.6.6.2 shall be of the varying speed type with reversible rotation and shall be of the following classification.

(a) Rating volts - 115 ac, 60 Hz.
(b) Revolutions per minute (rpm), horsepower (hp) and maximum torque - As required by the speed changing device.
(c) Duty, intermittent - 1/2 hour.
(d) Enclosure - Totally enclosed.
(e) Phases - Single phase without commutator.
(f) Bearings - Ball or sleeve.
(g) Ambient temperature - 40° to 122°F.
(h) Mounting - Horizontal.

3.7 Load-speed characteristics.

3.7.1 The definition of speed characteristics as defined in MIL-STD-178 are applicable and requirements are as specified in 3.7.1.1 through 3.7.1.2.2.

3.7.1.1 Where the governing system is of the electric speed and load sensing type, the performance requirements of type ST in MIL-G-21410 shall apply.

3.7.1.2 Where the governing system is of the hydraulic relay, centrifugally controlled type, performance shall be as specified in 3.7.1.2.1 and 3.7.1.2.2.

3.7.1.2.1 The mean governed speed shall be adjustable within 5.0 percent above and 5.0 percent below the rated speed from no load to maximum continuous rated load.

3.7.1.2.2 Under the conditions of test specified in 4.5.1 and 4.5.6 the speed regulation shall conform to the following requirements:

(a) Load-speed characteristics. The load speed curves from no-load to 100 percent continuous rated-load shall fall between parallel straight lines having the no-load to continuous rated-load speed droop shown in column 1 of table I and the load spread shown in column 2 of table I. The maximum and minimum values of speed droop from no-load to rated-load shall be as specified in column 3 of table I.
(b) Speed fluctuation. At any load from zero to 100 percent continuous rated load for sets having no overload capacity, the speed fluctuation for any constant load shall be not in excess of the values shown in column 4 of table I.

Table I - Load-speed characteristics.

Rated continuous kW load of generator set	Column 1 Droop of lines for limits of load-speed curves (percent)	Column 2 Load spread of lines for load speed curves (percent)	Column 3 Range of overall speed droop (0 to 100 percent load) as determined from columns 1 and 2 (percent)	Column 4 Maximum value of periodic speed fluctuations (percent)	Column 5 Maximum speed deviation following sudden load change (percent)
Up to 249 kW	3.1	30	2.2 to 4.0	0.15	6.0
250 kW and over	3.3	20	2.7 to 4.0	.15	6.0

(c) Sudden load change. The inertia of the generator set, the characteristics of the turbine and reduction gear (if a reduction gear is used in the design) and the response of the governor shall be such that upon sudden application of 80 percent continuous rated load in one step and sudden removal of 70 percent continuous rated-load in one step from the 80 percent load originally applied, the maximum speed deviation from initial speed shall not exceed the values shown in column 5 of table I. In addition, the speed shall return to, and remain within, 1.0 percent of the final steady state speed in not more than 2.0 seconds following the load application or removal.

3.8 Generator set voltage regulation.

3.8.1 For class A generator sets, the following voltage regulation shall apply:

(a) With the generator field rheostat, generator load and turbine speed adjusted so that the generator is operating at rated voltage, current and revolutions per minute (rpm) the rise in voltage shall be not more than 8.0 percent when the load is gradually reduced from rated-load to no-load in 20 percent steps.

(b) With the generator field rheostat, generator load and turbine speed adjusted so that the generator is operating at rated voltage, no-load and a speed corresponding to the no-load speed noted in (a) the drop in voltage shall be not more than 12.5 percent when rated-load is applied in 20 percent steps up to rated output.

(c) At any point on the voltage-load curve with the generator field rheostat adjusted as specified in (a) and (b), there shall be no rise in voltage with increase in load or any drop in voltage with decrease in load.

3.8.2 For class B generator sets, the requirements of MIL-R-2729 shall apply.

3.9 Generator set parallel operation.

3.9.1 For class A generator sets the parallel operation shall be as follows:

(a) The generator sets shall operate in parallel without equalizers so that at any load under the conditions of test specified in 4.5.1 and 4.5.12, the current load on any generator expressed as a percentage of its rated-load current shall not differ from the total system current load expressed as a percentage of the total rated-load currents of all connected generators, by more than 7.5 percent for generators of the same type, design and kW ratings or 15.0 percent for generators of different designs, types and kW ratings. For example, if four 120/240 volt, class A generator sets (A, B, C and D) rated 60, 100, 100 and 100 kW respectively are operating in parallel and at one point are delivering 165, 194, 195 and 196 amperes, respectively, with no current flowing in the neutral lead, generator A would not be meeting specification requirements. The generator sets would be meeting specification requirements at a certain point, however, if they were delivering 160, 196, 197, and 197 amperes, respectively, with no current flowing in the neutral lead.

(b) Where there are load currents in neutral leads of three wire generators operating in parallel, the larger of two main line currents in each generator set shall be used to determine if parallel operation requirements have been met.

3.9.2 Where class B generator sets are specified and electric speed and load sensing governors are not specified, the parallel operation shall be as specified in 3.9.2.1 and 3.9.2.2.

3.9.2.1 The generator sets shall operate in parallel in accordance with the kilovar (kvar) load (reactive power) division and circulating current requirements of MIL-R-2729 and in accordance with the following kW load (active power) division requirements. At any given load division under the conditions of test specified in 4.5.1 and 4.5.12 the actual kW load of any generator set, expressed as a percentage of its continuous kW rating, shall not differ from the total system kW load, expressed as a percentage of the total continuous kW rating of all generator sets, by more than the following:

(a) 5.0 percent for generators of the same size, type, design and rating.
(b) 10.0 percent for generators of unequal size and different type, design and rating.

3.9.2.2 When measured as specified in 4.5.12.2.2.1(b) the kW pulsation shall not exceed 3.0 percent of the rated kW of one generator set.

3.9.3 Where class B generator sets are specified and electric speed and load sensing governors are specified, the load division and current pulsation requirements of MIL-G-21410 shall apply.

3.10 Identification plate. An identification plate shall be furnished with each generator set and shall be installed on the bedplate in a location where it can be easily read without danger to personnel. This plate shall be constructed of corrosion-resisting steel, nickel-copper-alloy or brass. The markings on these plates shall be stamped, etched, engraved or cast in such a manner as to produce permanent and durable markings. All etchings, engravings or stampings shall be not less than 0.003 inch deep. The characters on cast plates shall be raised to at least 0.03 inch. All etched, engraved or stamped markings shall be filled with black enamel or lacquer. The plate shall include the following information:

(a) Generator set model (if assigned).
(b) Generator set serial number.
(c) Government stock number.
(d) Manufacturer's name.
(e) Contract identification data.
(f) "Space for inspectors stamp."
(g) Turbine model number.
(h) Turbine rpm.
(i) Generator data as follows:
    (1) Manufacturer's name.
    (2) Model or type.
    (3) kW rating.
    (4) Voltage and frequency rating.
    (5) Power factor rating.
    (6) Ac or dc.

3.10.1 Identification plates shall not contain any classified (Security) information. For the data which is indicated as classified by contract security provisions (form DD 254), the items shall be stamped with an asterisk only and the following added at the bottom of the plate:

* Classified data - See technical manual.

3.11 Repair parts and special tools.

3.11.1 Repair parts and special tools shall be furnished in accordance with the requirements of method A or B in MIL-P-15137 (see 6.5) as specified (see 6.1.1). Where method A is specified, onboard repair parts shall be based on the number of identical generator sets installed per ship, as specified (see 6.1.1), and the following:

(a) A set of special tools which are required for disassembly, repair, adjustment and reassembly, shall be furnished on a per ship basis. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service (DCAS)).
(b) The specific repair parts and quantity of each part shall be furnished as specified in the individual equipment military specification.

(c) Where special tools are required for installation and alignment of the generator set, one set of such tools shall be shipped with the first generator set scheduled for installation on any one ship.

3.12 Technical manuals (see 6.1.2). Technical manuals shall conform to type I of MIL-M-15071 except as modified herein.

3.12.1 Validation. Validation is required only for those items specified hereinafter. Once a procedure has been validated, re-validation is required only when the design of the part or the arrangement of parts has been changed. Re-validation when only the part number designation has been changed is not required. The manufacturer shall make every effort to complete validation prior to submission of preliminary manuals for acceptance. Where such validation is not completed, correspondence forwarding preliminary manuals shall show the portions of the manual which have not been validated. All validation shall be completed prior to printing of final manuals. Where validation cannot be completed in time to permit shipment of final manuals with generator sets, corrected preliminary manuals may be shipped with equipment in accordance with MIL-M-15071.

3.12.1.1 Items which require validation. Items which require validation shall be as listed below. Validation of subcontractor furnished items may be accomplished at the subcontractor's plant where such validation is not affected by equipment furnished by the contractor or other subcontractors. For example, validation of the procedure for adjusting generator brushholders, brush spring tension and replacement of brushes may be accomplished at the generator manufacturer's plant provided the location of other units or the location of such items as piping on the completely assembled generator set does not change the procedure.

(a) Procedure for determining whether the generator set is properly alined.
(b) Procedure for examination and replacing all journal bearings (including checking bearing clearance).
(c) Procedure for examination, determining clearances and replacement of all seals.
(d) Procedure for taking thrust clearance, installing thrust locking device, examination and replacement of thrust shoes and for taking total float clearance on thrust bearings.
(e) Procedure for checking axial clearance of turbine rotor.
(f) Procedure for examination, replacement and setting of parts in the overspeed trip assembly, the low bearing oil pressure trip assembly and the back pressure trip assembly.
(g) Procedure for examination of control valves and linkages including setting instructions.
(h) Procedure for examination and replacement of parts in the turbine driven lube oil pump and the associated drive assembly.
(i) Procedure for examination and replacement of parts in the gland seal regulator.
(j) Procedure for examination and replacement of parts in the throttle valve.
(k) Procedure for examination of condensers and air ejectors and replacement of zincs, as applicable.
(l) Procedure for examination of generator air coolers and replacement of zincs, as applicable.
(m) Procedure for balancing the rotating elements (turbine rotor, pinion and gear, generator rotor, as applicable) of the generator set.
(n) Procedure for adjusting generator brushholders, brush spring tension and replacement of brushes, as applicable.
(o) Confirm that lubrication characteristics and procedures (pressures, temperatures, areas to be lubricated and frequency of lubrication, as applicable) agree with information in the technical manual.
(p) All wave forms, oscilloscope traces, voltages and currents involved in the trouble shooting procedures for voltage regulator, static type excitation systems and the electric speed and load sensing type governor, as applicable.

3.12.2 Outline of manual. The manual may be sectionalized as necessary to provide major divisions under each chapter, each covering one unit such as governor, reduction gear, turbine, condenser, air ejector, lube system, generator, excitation and voltage regulator system and special devices and systems. The format and content of the manual shall be as follows:

(a) Front matter.
(b) Chapter 1 - General information.
  (1) Section 1 - General description of the generator set and all detached accessories.
  (2) Section 2 - Descriptive data for major units.

(c) Chapter 2 - Operation.
(d) Chapter 3 - Functional description.
(e) Chapter 4 - Scheduled or preventative maintenance.
(f) Chapter 5 - Trouble shooting.
(g) Chapter 6 - Corrective or overhaul maintenance.
(h) Chapter 7 - Parts and special tools list.
(i) Chapter 8 - Installation.
(j) Chapter 9 - Appendix.
    (1) Section 1 - List of drawings.
    (2) Section 2 - Fold-out copies of drawings.
    (3) Section 3 - A copy of test results on the first generator set of a design, type and size.

3.12.3 General requirements.

3.12.3.1 Where the manual consists of more than one volume, in order to meet the specification limit on maximum thickness of 3 inches, chapter 9 shall be contained in the last volume.

3.12.3.2 Photography. The use of photographs to supplement description and maintenance coverage shall be required. As a minimum, photographs or sketches of the following items shall be included:

(a) Completely assembled generator set. One view each from the right and left hand sides of the set.
(b) Turbine assembly with upper half-casing removed.
(c) Reduction gear assembly (if reduction gear furnished) with upper half-casing removed.
(d) Method of taking crown thickness.
(e) Thrust bearing showing leveling plates and pads.
(f) Lube oil system pressure control valve.
(g) Special couplings such as those with resilient composition inserts.
(h) Trip throttle valve.
(i) Back pressure trip assembly.
(j) Thrust collar locking device.
(k) Atmospheric relief valve.
(l) Typical gland and diaphragm packing assembly.
(m) Low bearing oil pressure and manual trip assembly.
(n) Typical diaphragm support.
(o) Typical turbine and gear journal bearing.
(p) Turbine rotor assembly.
(q) Lube oil pumps and drives (attached and motor driven).
(r) Generator rotor assembly.
(s) Generator bearing.
(t) A typical RTD installation.
(u) Generator excitation system units. Where rotating exciter is used, photographs of the rotating assembly and of the voltage regulator (with cover removed) shall be furnished. Where a static type exciter-voltage regulator is furnished photographs of each major unit are required. Where covers are provided with the units or where various units are mounted within an enclosure to meet the requirements of specifications, photographs shall be taken with covers removed or with the doors in the open position, as applicable.
(v) Electric speed and load sensing governor units (if furnished). Where covers are provided for these units to meet specification requirements, photographs shall be taken with the covers removed.
(w) Typical wave forms and oscilloscope traces for trouble shooting the generator voltage regulation and excitation system, the electric speed and load sensing governor system, as applicable.

3.12.3.3 Double column or single column printing is acceptable. Paragraph or group headings shall be of either bold type or capital letters.

3.12.3.4 Numbering. A decimal system of numbering shall be used for the text.

3.12.3.5 Final manual. The following requirements apply.

(a) Cover size. Approximately 9-1/2 by 11-1/2 inches, with index margin tab allowance.
(b) Index margin tabs. Hard durable tabs (on page size separators and not protruding beyond binder edge) with arabic numeral for each chapter shall be included.

3.12.4 Detail requirements. Detail requirements for manual contents are specified in 3.12.4.1 through 3.12.4.10. These requirements take precedence over MIL-M-15071 except where otherwise specified.

3.12.4.1 Front matter. The requirements of MIL-M-15071 shall apply.

3.12.4.2 Chapter 1 - General information and data. Chapter 1 shall consist of the following:

(a) Section 1 - Section 1 shall briefly describe the generator set and detached accessories showing physical characteristics (size and weight, and so forth) of these items and showing general performance characteristics (including frequency and voltage) under steady state and transient load conditions and under the specified steam and exhaust conditions. Any special features such as noise reduction shall be covered.

(b) Section 2 - Section 2 shall briefly describe physical and operating characteristics, and manufacturer's type or model designations for the turbine, lubricating oil pumps and motor (if provided), lube oil cooler, reduction gear (if provided), generator, generator excitation system, speed and load sensing governors, generator air cooler (if provided), condenser and air ejector (if provided).

3.12.4.3 Chapter 2 - operation. Guidance for operating the turbine generator set shall be provided for the areas listed below. Information on all operational limitations such as maximum back pressure, allowable bearing temperatures, minimum and maximum oil pressures, minimum and maximum oil inlet temperatures, maximum ambient compartment temperatures and other parameters to provide specific guidance for operation of the turbine generator set including detached accessories shall be provided.

(a) Safety precautions.

(b) Examination and checks to be made prior to starting. This information should include data to show the correct position of adjusting devices (such as valves, rheostats, switches, circuit breakers, and so forth) prior to starting the unit.

(c) Step-by-step procedure for starting the unit including the sequence of opening and closing valves and the sequence of operating and the setting of all switches, rheostats and circuit breakers (including those associated with electric speed and load sensing governors and the generator excitation system). This procedure shall also show details of the warming up period including rate of increase in speed, the speeds in rpm where the generator set is operated during the warm up period and the time involved at each speed.

(d) Step-by-step procedure for operation of the generator set as a single unit after the warm up period has been completed and the generator set is operating at rated speed. The sequence of operating all switches, rheostats, circuit breakers and valves shall be shown for conditions where the excitation system control switch is in the manual and automatic position.

(e) Step-by-step procedure for paralleling generator sets.

(f) Step-by-step procedure for securing the generator set including the sequence of opening and closing valves and the sequence of operating all switches, rheostats and circuit breakers. Note: When circuit breakers, condensate and cooling water pumps, and associated valves are not furnished by the generator set manufacturer, operation instructions shall be formulated on the basis that the installing activity will normally furnish the following items and appropriate reference to these items shall be contained in the step-by-step operating procedure.
  (1) Generator circuit breaker.
  (2) Valves for cooling (sea) water supply to coolers, heat exchanges and condenser.
  (3) Valves for condenser condensate.
  (4) Condensate pump and pump for cooling (sea) water supply.
  (5) Valve in steam supply line to air ejector.
  (6) After condenser drain valves.
  (7) Valves for draining water from steam supply lines.
  (8) Steam inlet valve to turbine.
  (9) Valves for various turbine drain lines such as throttle and casing drains.
  (10) Synchroscope.

(g) Procedure for switching from one filter or strainer element to the other, the proper method of cleaning, precautionary notes regarding reassembly to

assure that there are no oil leaks and, what pressure drop across the element indicates that cleaning is required.

(h) Procedure for using turning devices required by MIL-T-24398. For power operated turning devices indicate the maximum turbine speed at which the device can be engaged and disengaged and how to determine when the turbine rotor has stopped turning.

3.12.4.4 Chapter 3 - Functional description. The intent of this chapter is to show a detail functional description of each unit furnished with the generator set, a step-by-step explanation of the operation of the generator set to show how each unit is involved and why adjustments are required to maintain optimum performance. This chapter shall show the step-by-step sequence of operation of all units of the generator set (during the start-up, operation and securing phases) and shall include block diagrams, simplified schematic diagrams, performance curves, and so forth as necessary, and reference to these items made in the write-up, so that the function of each unit and its affect on the performance of the generator set may be clearly understood. The minimum items to be covered shall be as follows:

(a) Governor system (including any linkage involved) and accumulators (where used).
(b) Lube oil system.
(c) Gland seal and drain system.
(d) Turbine steam chest valves and linkage.
(e) Turbine throttle valve.
(f) All safety and alarm devices.
(g) All indicating devices.
(h) All control devices.
(i) Generator excitation and voltage regulation system.
(j) Generator.
(k) Bearings.

3.12.4.5 Chapter 4 - Scheduled or preventative maintenance. The intent of this chapter is to show information on routine maintenance procedures to prevent unscheduled shutdown of the generator set due to failure of units or where units deteriorate to the point where the generator set will not meet the performance requirements of this specification during the operating time between ship overhaul periods specified in 3.2.3.4(d). Routine maintenance shall not involve alinement or complex adjustments as the generator set shall be designed to eliminate the need for accomplishing such items during the operating time between ship overhaul periods. This chapter shall include a list of planned maintenance actions based on those shown on figure 1 and the following information for accomplishing each action.

(a) Step-by-step procedure (including procedure for disassembly and assembly of units or parts, as applicable).
(b) Tools and instruments needed.
(c) Estimated time.
(d) Details of any minor adjustments and minor parts replacement (brushes, fuses, gages, thermometers, and so forth) involved.

3.12.4.6 Chapter 5 - Trouble-shooting. The intent of this chapter is to show trouble-shooting information for isolating the unit or part which has failed or which is functioning improperly. Chapter 5 shall consist of the following sections:

(a) Section 1 - This section shall be arranged in table form with three vertical columns. The first column shall be titled "Symptom"; the second column shall be titled "Probable cause", and the third column shall be titled "Remedy". All items under the "Remedy" column which involve checks, inspections, repairs, replacement of parts, cleaning and adjustments shall refer to the section and paragraph in the manual where detail procedures for accomplishing these items may be found. Where the "Remedy" column for electrical items involves checking voltages, wave forms and current in circuits, information shall be added to identify the specific points in the circuit where measurements are made by appropriate reference to drawings included in the manual. As a minimum, the trouble-shooting table shall show probable causes and remedies for the following symptoms.
(1) Loss of lubricating oil pressure.
(2) Bearing temperatures abnormally high.
(3) Vibration abnormally high.
(4) Frequency varies with constant load.
(5) Recovery of frequency abnormally slow after sudden application or removal of load.
(6) Low lube oil pressure.

(7) Low control oil pressure.
(8) High lube oil pressure.
(9) High control oil pressure.
(10) Generator sets will not share kW load during parallel operation.
(11) Generator sets will not share reactive load during parallel operation.
(12) Turbine trips off line inadvertently when operating personnel do not initiate action to trip unit off the line.
(13) Turbine fails to trip when tripping device operated by personnel.
(14) Steam chest linkage operation sluggish.
(15) Low vacuum or fluctuating vacuum.
(16) Excessive condensate depression.
(17) High salinity for condenser condensate.
(18) High circulating water temperature at discharge end of condenser.
(19) High temperature on steam side of condenser.
(20) Low generator insulation resistance.
(21) Excessive sparking between generator brushes and slip rings or commutator.
(22) Generator brushes chattering.
(23) Generator voltage will not build-up.
(24) Where field flashing of generator is involved.
a. Generator field cannot be flashed.
b. Generator voltage drops to zero when flashing power is removed (regulator control switch in manual and automatic positions).
(25) Generator voltage goes to ceiling (turning regulator control switch to manual or automatic has no effect).
(26) Generator voltage goes to ceiling (turning regulator control switch to manual results in correct operation).
(27) Low generator voltage (below rated voltage) with little or no control.
(28) Poor voltage regulation under constant load conditions (voltage does not remain with required band limits at all loads between no load and rated value).
(29) High generator voltage (over rated voltage) with limited control.
(30) List of special tools and all instruments required for trouble-shooting.

(b) Section 2 - This section shall contain a detail description of trouble-shooting procedures which are too lengthy to include in the trouble-shooting chart required under section 1 and where such procedures are not shown in other chapters of the manual.

3.12.4.7 Chapter 6 - Corrective or overhaul maintenance. The intent of this chapter is to show information on examinations, and the criteria for adjustment, repair or replacement of parts resulting from the examinations during the ships overhaul period so that when overhaul work is completed, the generator sets will operate for the specified hours between ships overhaul periods without unscheduled shutdowns for corrective maintenance when the scheduled or preventative maintenance items in chapter 4 are accomplished. Procedures and instructions related to overhaul maintenance actions which will be performed by shipyard personnel shall cover the following items.

(a) Safety precautions.
(b) Removal of upper turbine casing and bearing brackets for examination of turbine blades, diaphragms, valves, seals, bearing journals, bearings and associated clearances.
(c) Removal of upper gear casing (where gear is furnished) for examination of tooth contact, bearing journal surfaces, bearings and associated clearances.
(d) Criteria for determining whether a part is in need of repair or replacement.
(e) Disassembly and reassembly procedures including sequence of removing and tightening bolts, pattern for stretching bolts and securing joints and a torque table for tightening critical bolts and nuts, where applicable.
(f) Acceptable range of clearances between all rotating parts and between all rotating and stationary parts.
(g) Cleaning procedures for units and parts after they are disassembled.
(h) Procedures for measuring bearing wear.
(i) Procedure for examining and replacing turbine blades.
(j) Procedure for examining and replacing gland seal rings.
(k) Procedure for testing and adjusting, repairing and replacing parts in the overspeed trip assembly.
(l) Procedure for examining repair and replacement of parts in the bearing low oil pressure and manual trip assembly.
(m) Procedure for examination, repair and replacement of parts involved in the steam chest, valves and linkages.
(n) Procedure for examination, repair and replacement of parts in the throttle valve.

(o) Procedure for examination, repair and replacement of parts in the lube oil cooler.
(p) Procedure for examination, repair and replacement of parts in the turbine driven oil pump and drive assembly.
(q) Procedure for examination, repair and replacement of parts in the electric motor and lube oil pump assembly (when this assembly is furnished).
(r) Procedure for examination, repair and replacement of parts in strainers and filters.
(s) Procedure for examination, repair and replacement of parts in the back pressure trip assembly.
(t) Procedure for examination, repair and replacement of parts in the gland seal regulator.
(u) List of special tools, lifting slings and guides provided and indicate where these items are used.
(v) Procedure for examining and repairing condensers and air ejectors (including replacement of zincs provided to minimize electrolytic action).
(w) Procedure for checking alinement of turbine, reduction gear (if reduction gear furnished) and generator.
(x) Procedure for checking alinement of internal shafting, couplings and bearings involves in driving turbine or gear accessories.
(y) Procedure for examination, repair and replacement of parts in the governor assembly.
(z) Procedure for examination, repair and replacement of parts in the generator air cooler.
(aa) Procedure for adjusting all protective devices.
(bb) Procedure for balancing the rotating elements of the generator set so that the complete generator set will meet the vibration limits specified herein. This procedure shall include how and where to take phase angle measurements, (on basis of markings provided on the shaft) as required by MIL-T-24398.
(cc) Procedure for drying out electrical equipment. Also show the criteria (minimum insulation resistance reading) for determining whether the particular part should be dried out.
(dd) Procedure for adjusting generator brushholders and brushholder springs (showing criteria for determining proper adjustment) and replacement of brushes (showing criteria for determining when brushes should be replaced).
(ee) Procedure for refinishing commutators and collector rings showing maximum allowable eccentricity after refinishing. Also show the criteria for determining whether rings or commutators should be refinished. (Also show the procedure for regrooving collector rings where grooved rings are furnished and the minimum depth of groove before regrooving is necessary.
(ff) Procedure for examination, adjustment, repair and replacement of all seals, seal rings and like items and the criteria for determining the need for adjustment, repair and replacement.
(gg) Procedure for rewinding the generator rotor and stator coils. Also show the reassembly procedures for the generator rotor and stator after rewinding has been accomplished.
(hh) Procedure for determining whether units or parts in the electric load sensing governor are in need of adjustment, repair or replacement (if this type governor is furnished).
(ii) Procedure for determining whether units or parts in the voltage regulator and exciter are in need of adjustment, repair or replacement.
(jj) Procedure for checking performance of complete generator set after all adjustments, repairs, balancing and alinement has been completed during this ships overhaul period. This procedure should include reference to the generator set test data shown under chapter 9 of the manual as a means of comparison to determine whether the generator set performance is optimum.
(kk) Procedure for adjusting and testing the overspeed trip assembly. Also show the maximum resetting speed for this assembly.
(ll) Where an accumulator is used, show the procedure for determining whether it is functioning properly, the criteria for determining when recharging is required and the detail procedure for recharging.

3.12.4.8 Chapter 7 - Parts and special tools list. Chapter 7 shall consist of the following:

(a) Section 1 - This section shall contain a list of all units and their maintenance parts. The parts list shall provide ready means of identifying parts with manufacturer's part number or drawings and piece number. The parts list shall correlate manufacturer's numbers with illustrations in the manual. The illustrations shall include a parts list or legend showing the manufacturer's drawing and piece number. The listing shall be arranged by units

and the basis of the items and quantities specified as repair parts in individual equipment specifications plus any other parts which the manufacturer considers necessary to support the generator sets during the hours of operation between ships overhaul periods specified herein. Further the list of parts shall include those additional parts which the manufacturer recommends the Navy have on hand for use during the ships overhaul period. The list of parts shall consist of the following data:

(1) Name of unit and name and description of part.
(2) Identify part location by referencing applicable drawing and piece number or drawings or illustrations included in the manual.
(3) Quantity of each part contained in one generator set.
(4) Identification of manufacturer of each part (if this data is not shown on referenced drawings).

(b) Section 2 - A reduced size copy of the latest approved version of the provisioning lists (NAVSHIPS 4786 and 4786A) covering all units of the generator set. The latest approved version is considered to be the one available at the time the technical manual is ready for printing.

(c) Section 3 - This section shall include a list of special tools supplied with the generator sets.

3.12.4.9 Chapter 8 - Installation. Chapter 8 shall consist of the following:

(a) Section 1 - Reference shall be made to installation drawings for the generator set and detached accessories. Installation information, as necessary and as determined by the generator set manufacturer shall be added to supplement these drawings.

(b) Section 2 - Section 2 shall cover the following as a minimum requirement.
(1) Show procedure for handling equipment prior to unpacking.
(2) Show procedure for unpacking equipment.
(3) Show procedure for handling equipment after it is unpacked.
(4) Show tools required and step by step procedure for attaching units to the generator set where these units have been removed for shipping purposes.
(5) Show step-by-step procedure for checking alinement of generator set after it has been secured to ships foundation.
(6) List safety precautions.
(7) Show procedure for any inspections to be made prior to starting or energizing the generator set or detached units for the first time onboard ship.
(8) Show step-by-step procedure for starting, operating, and securing the generator set for the first time onboard ship. This procedure shall show the normal readings for all indicating devices (gages, meters, and so forth) during the starting, operating and securing phases of of the generator set and all accessories. In addition, this procedure shall show the operating sequence for all devices requiring adjustment (such as valves, switches, rheostats, circuit breakers) during the starting, operating and securing phase. Note: Where procedures for unpacking equipment and for handling equipment after unpacking are covered by the unpacking instructions required by 5.1.4, in lieu of showing the procedures as required by 3.12.4.9(b)(2) and (b)(3), reference to the unpacking instructions will be acceptable.

3.12.4.10 Chapter 9 - Appendix. Chapter 9 shall consist of the following:

(a) Section 1 - This section shall consist of a list of the following drawings:
(1) Major assembly drawings of all units.
(2) Generator set installation drawing or drawings.
(3) Drawings which are referenced on the generator set installation drawing or drawings.
(4) Detail drawings, as necessary, to supplement operating, preventative maintenance, overhaul maintenance and trouble-shooting instructions in the manual, and to identify repair parts.

(b) Section 2 - This section shall include legible fold-out copies of the approved versions of drawings required by section 1 of this chapter and approved versions of the following electrical drawings.
(1) Electric load and speed sensing governor system (if this system supplied with generator set).
(2) Generator.
(3) Generator excitation system.

(c) Section 3 - This section shall contain information on the results of tests on the first generator set subjected to the design inspection shown in table II and the results of tests on the generator excitation system and the electric speed and load sensing governor system (if furnished with generator set) required by the individual equipment specifications. A list of all tests using the description of test shown in table II and in the individual equipment specifications, as applicable, and the results of each test shall be shown. Results of tests may be shown on the forms prepared by the manufacturer as required by 4.3.2.

3.12.5 Review procedures for preliminary manuals.

3.12.5.1 The preliminary draft of the technical manual shall contain all the information which the generator set manufacturer proposes for the final manual except for photographs and results of tests.

3.12.5.2 Preliminary drafts of the manuals shall be submitted for review in the quantity, on the date and to destinations as specified (see 6.1.1).

3.12.6 Final manuals. Responsibility for preparing final manuals, quantity of manuals required, date manuals are required and distribution of final technical manuals shall be as specified (see 6.1.1).

3.12.7 Replenishment material for technical manuals shall be furnished as required by MIL-M-15071. Such material shall be forwarded to Director, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

3.13 Drawings and drawing list (see 6.1.2).

3.13.1 Assembly and detail drawings. Assembly and detail drawings for the individual equipments (i.e., turbine, gear, generator, etc.) shall be prepared as specified in the individual equipment specification.

3.13.2 Generator set installation drawing(s). Installation drawings for the complete generator set shall be prepared containing the following information in addition to that required by MIL-D-1000/2.

(a) Dimensional outline drawings (four view drawing) of the generator set and each detached accessory. These drawings shall identify and show the locations of shipbuilder connections (mechanical and electrical). The drawing shall also include a sketch of the generator set identification plate with all plate markings and the location of the plate.
(b) Piping diagrams, showing all connections for oil, water, steam, air, and exhaust necessary for proper installation and operation of the generator set. The size, type, dimensions of all flange type connections (for installation of ships piping) such as outside diameter, thickness, number of holes, bolt hole diameter, bolt circle and face shall be shown.
(c) A complete electrical system schematic wiring diagram shall be furnished. The diagram shall show the identification of various units in block form with all terminal designations associated with wiring to be completed by the installing activity. All wiring to units or between units to be completed by the activity installing the generator set shall be represented by dotted lines and all wiring completed by the generator set manufacturer shall be represented by solid lines. All wiring shown in dotted lines shall be coded in a manner to indicate the maximum current involved in each of the cables represented by dotted lines.
(d) Type number, ratings (volts, amperes, rpm, kW, and so forth) and the name of the manufacturer of all electrical equipment.
(e) Outline and complete description of circuit breaker trip switch (for class A only).
(f) Table of weights showing dry weights of all major units (such as turbine complete, reduction gear complete (if reduction gear is furnished), generator set bedplate, condenser (if furnished), air ejector (if furnished), oil cooler, electric motor driven lube oil pump (if furnished)), and the dry weights for the complete generator set packages.
(g) Location, service and range of all gages and thermometers. A sketch of the turbine gageboard showing mounting features and the location and idenfitication of all gages shall be included witn the installation drawings.
(h) A complete performance data table for the turbine, condenser (if furnished),

air ejector (if furnished), lube oil cooler and generator air cooler (if furnished).

(i) A graphic presentation of allowable forces and moments on, and thermal expansion of, steam inlet and outlet connections.
(j) Estimated quantities of steam and air leakage at leakoff connections.
(k) Bearing data, including loads, surface speeds and pressure angles.
(l) Clearance required to remove the generator rotor, generator air cooler, upper casings for turbine and reduction gear, tube assembly for auxiliary condenser and after condenser (if furnished).
(m) All openings for examination or clearance measurements.
(n) The WR^2 of major rotating parts (generators, gear and turbine).
(o) The maximum amount of heat in British thermal units (Btu) per hour dissipated by the generator set into the space where the set will be installed.
(p) Steam flow, air flow and temperature characteristics for the gland seal system.
(q) The installation drawing covering equipment which has been shock tested and found satisfactory shall contain the following note "This generator set has satisfactorily passed shock tests as recorded in (show shock test activity) test report number (show test report number) dated (show date of test report) under Government contract number (show Government contract number)".
(r) As a minimum, the following drawings shall be referenced on the basic outline and general arrangement drawing for the generator set.
  (1) Any drawings which show installation features of the generator set and which supplement the general arrangement drawing.
  (2) Turbine assembly.
  (3) Reduction gear assembly (if gear furnished).
  (4) Generator assembly.
  (5) Auxiliary condenser assembly (if condenser furnished).
  (6) Auxiliary air ejector assembly (if ejector furnished).
  (7) Voltage regulator and exciter assembly (where applicable).
  (8) Electric motor driven auxiliary pump unit assembly (where applicable).
  (9) Electric load and speed sensing governor assembly (if this type governor furnished).
  (10) Paralleling monitor device (if device furnished).
  (11) Lifting arrangement drawing.
  (12) Drawing list.
(s) The frequency involved in the first through the fifth torsional criticals for the generator set.
(t) A sketch to illustrate the use of lifting and handling gear for the generator set package.
(u) The WR^2 of the combined generator set (turbine, gear and generator), referred to the generator speed.

3.13.3 Drawing list. If specified (see 6.1), a drawing list shall be prepared for the complete generator set and its attached and detached accessories, and all drawings applicable to the equipment furnished shall be listed thereon. The list shall provide a breakdown with an alphabetized index by major assemblies.

3.13.4 Preliminary drawings for review. The contractor shall submit to the ordering activity the required number of copies of preliminary drawings as specified (see 6.1.1).

3.13.5 Final drawings. Final drawings shall consist of microfilm of all installation, assembly, and detail drawings as specified (see 6.1.1).

3.14 Equipment variations. Equipment which does not conform to contractual requirements shall be handled in accordance with the provision of the contract. Other variations which result in conforming equipment but constitute variations from standard production units, accepted drawings, accepted materials and accepted processes, shall be handled in accordance with the following procedures. Specific examples of these deviations are:

(a) Manufacturing errors which necessitate special repair procedures or the use of nonstandard parts.
(b) An improperly applied process procedure or a substitute process which does not adversely affect the end use of the part or assembly involved.

3.14.1 Disposition. Variations which affect installation, reliability, maintainability, performance, repair parts (onboard and shore based) or interchangeability of parts which would be repaired or replaced during maintenance of equipment require Government acceptance.

3.14.2 Conditions for acceptance of parts having variations. Variations will be accepted under the following conditions which shall be supported by the generator set manufacturer when acceptance of variations are requested:

(a) The effect of the variation either in the as-is condition or with the part modified is technically acceptable to the Government.
(b) The nature of the part involved is such that replacement is not economically justified.
(c) Where parts involved are normally onboard repair parts, one of each nonstandard part shall be furnished for each generator set involved as an onboard repair part and two of each nonstandard part shall be furnished as stock spares.
(d) Where parts involved are normally stock repair parts and not onboard repair parts, two each of the nonstandard part shall be furnished as stock repair parts.
(e) The repair parts furnished in accordance with (c) and (d) shall consist of the lowest echelon of parts required to compensate for the variation. For example, if a shaft bearing journal is machined undersize necessitating the use of nonstandard bearings, spare nonstandard bearings shall be furnished and a spare nonstandard shaft need not be furnished.
(f) Separate provisioning documentation for nonstandard repair parts shall be submitted in accordance with MIL-P-15137 (see 6.5). The unit involved shall be identified by unit serial number, generator set serial number and ship involved. The documentation shall also show that the listed parts are nonstandard.
(g) An equipment variation summary drawing together with certification that resultant special parts have been furnished, shall be submitted for all variations accepted under each contract.
(h) The requirements in (c) and (d) apply only where the variation affects interchangeability.

3.14.3 Procedure for acceptance or rejection of variations. The procedure specified in 3.14.3.1 and 3.14.3.2 shall be used for acceptance or rejection of variations.

3.14.3.1 Where shipbuilder furnished equipment is involved. The following procedure shall be used:

(a) Variations shall be referred to NAVSHIPS/NAVSEC via the DCAS, the procurement activity and the cognizant shipbuilder and Supervisor of Shipbuilding within 30 days after occurrence. In order to expedite review action, a copy of correspondence requesting acceptance of variations and associated supplementary data shall be forwarded direct to NAVSEC. Any work done on equipment with variations prior to obtaining Government acceptance shall be at the contractor's risk.
(b) Each variation shall be accompanied by a letter report containing the following:
  (1) The contract number and identification of the item involved.
  (2) A complete description (including drawing or sketch to scale) showing the nature and extent of the variation, including details of the original part and as proposed to be furnished.
  (3) The effect of the variation (as corrected) on the performance, installation, reliability, maintainability and interchangeability of the generator set including detailed engineering basis for acceptance.
(c) Copies of all correspondence involving repair parts shall be forwarded to the Ships Parts Control Center, Mechanicsburg, Pa. 17055.

3.14.3.2 Where government furnished equipment is involved, the requirements of 3.14.3.1(a) through (c) apply except that variations shall be submitted to NAVSHIPS/NAVSEC via the procuring activity where other than NAVSHIPS is involved and direct to NAVSEC where the procuring activity is NAVSHIPS.

3.14.4 Machining errors and equipment variations which are not covered by 3.14.1 (such as non-significant and non-critical deviations from drawing dimensions or tolerances for castings, forgings, weldments, connections or machine processed parts) do not require review by the Government. However, each deviation shall be documented and a copy of such documentation furnished to the DCAS. If the DCAS considers that the deviation involves contractual requirements or meets the criteria in 3.14.1, the procuring activity, the Supervisor of Shipbuilding (if shipbuilder furnished equipment is involved), NAVSEC and the generator set manufacturer shall be notified. If NAVSEC agrees with the DCAS, the deviation shall be treated in accordance with the procedure noted in 3.14.2 and 3.14.3. When repair restores

a part to original drawing dimensions, and where such repair does not involve a change in material, and uses a previously accepted repair process, the DCAS shall accept such repair.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Quality program. The supplier shall provide and maintain a quality program acceptable to the Government for supplies and services covered by this specification. The quality program shall be in accordance with MIL-Q-9858 (see 6.5).

4.3 Performance tests.

4.3.1 Unit tests and test agenda.

4.3.1.1 Unit tests. All units shall be tested in accordance with individual equipment specifications. It is preferred that these tests be conducted at the place of manufacturer prior to final assembly of the generator set. However, if it is more practical to conduct all or part of the required unit tests after final assembly of the generator set, such method of conducting unit tests is acceptable provided all necessary loading and instrumentation facilities are available and tests are conducted in strict compliance with the applicable specifications.

4.3.1.2 Test agenda. The contractor shall submit three copies of a test agenda to the procuring activity concerned for review at least 90 days prior to conducting tests. This agenda shall list all tests to be conducted on the assembled generator set and on individual units. Each test shall be identified by the applicable equipment specification for units, this specification for generator set tests and the applicable paragraph number and title of test shown in the specification. The agenda shall indicate where each test is to be conducted.

4.3.2 Test reports (see 6.1.2). Test results shall be recorded on test forms prepared by the generator set manufacturer. Each test report shall have a cover sheet which shall show the applicable contract number, the applicable ship program, the kW rating of the complete generator set, the date tests were completed and shall reference this specification. Each test report form shall identify the test by reference to the applicable paragraph number and title of test shown in this specification and in individual equipment specifications where individual equipment tests are conducted after final assembly of the generator set. Where individual equipment tests are conducted at a location other than the generator set manufacturers plant, copies of the results of these tests shall be included in the test report. Where oscillograms are required, each trace shall be identified as to the circuit measurement involved and its calibration shall be indicated to permit easy evaluation without reference to associated documents. Where meter readings with multiplying factors are involved, the test report shall show the magnitude of these factors in each of the cases. Where adjustment, repair or replacement of parts is needed during the tests specified herein, the following data shall be recorded on the test report:

(a) A detailed description of the adjustment, repair or replacement.
(b) Description of corrective action taken to eliminate the need for such adjustment, repair or replacement after generator sets are shipped by the manufacturer and placed in service.
(c) Number of operating hours on the generator set before adjustment, repair or replacement of parts was accomplished.

4.3.2.1 Three copies of the design test reports shall be furnished to the procuring activity.

4.3.3 Sampling.

4.3.3.1 Sampling for design and periodic inspection. The first generator set of a design, type, and size shall be subjected to the specified design inspection (see 4.4.1). Thereafter, one identical generator set of each design, type, and size shall be subjected to the specified periodic inspection (see 4.4.2) every 2 years during which generator sets

are offered for delivery. A design inspection shall be conducted after any design change which affects performance characteristics. Where the manufacturer has conducted design or periodic inspection within a 2 year period prior to receipt of a request to bid, the bid proposal shall contain a statement to indicate whether the manufacturer intends to conduct periodic inspection. If statement indicates the manufacturer does not intend to conduct periodic inspection, one copy of the latest design or periodic inspection report with adequate abstract shall be furnished to verify that the generator set proposed is identical in design to the one covered in the test report and to verify conformance with the design and periodic inspection requirements specified herein.

4.4 Examination and tests. The generator set shall be subjected to the examination and tests shown in table II, as applicable. All examination and tests shall be conducted with the generator set operating as a complete unit with all attached and detached accessories. When conducting routine examination and tests, the same detached accessories may be used to examine and test each generator set provided each detached accessory supplied under the contract or order is examined and tested in accordance with the individual equipment specification covering the particular accessory. For example, where static type excitation systems are furnished (type III of MIL-R-2729) as detached accessories, only two of these excitation systems would be required for generator set parallel operation tests and these two systems may be used to conduct tests on remaining generator sets being furnished provided all other excitation systems have been subjected to the tests required by MIL-R-2729.

Table II - Examination and tests for turbine generator sets.

Examination or test	Examination or test paragraph	Examination and test condition	Design inspection	Periodic inspection	Routine inspection
Examination	4.5.1	A	X	X	X
Air gap	4.5.2	A	X	X	X
Preliminary run	4.5.3	E	X	X	X
Rated load (4-hour)	4.5.4.1	F	X	X	-
Rated load (1-hour)	4.5.4.2	E	-	-	X
Mechanical balance	4.5.5	E	X	X	X
Governor	4.5.6	F	X	X	X
Voltage regulation	4.5.7	F	X	X	X
Commutation	4.5.8	F	X	X	X
Rheostat	4.5.9	E or F	X	X	-
Effectiveness of enclosure	4.5.10	A	X	X	-
Lubrication	4.5.11	As required	X	X	X
Parallel operation	4.5.12	F	X	X	-
50-hour test	4.5.13	F	X	-	-
Inclination	4.5.14	C	X	-	-
Weight and center of gravity	4.5.15	A	X	-	-
Safety device	4.5.16	D	X	X	X
Shock	4.5.17	B	X	-	-
Noise	4.5.18	E	X	X	-
Steam consumption	4.5.19	F	X	-	-
Special environmental vibration	4.5.20	As specified (see 6.1.1)	X	-	-
Post test examination	4.5.21	A	X	X	X
Maintainability demonstration	4.5.22	A	X	-	-

4.4.1 Routine inspection. Each generator set shall be subjected to the routine inspection shown in table II to determine conformance with the requirements of this specification. Nonconforming generator sets shall be individually rejected.

4.4.2 Periodic inspection. Each sample generator selected in accordance with 4.3.3.1 shall be subject to the periodic inspection shown in table II.

4.4.3 Design inspection. The first generator set of a design, type and size shall be subjected to the design inspection shown in table II.

4.4.4 General test conditions.

4.4.4.1 Test conditions are defined as follows:

(a) Condition A. Turbine-generator set is idle (no-load, no speed, no steam to or exhaust from the turbine).
(b) Condition B. Turbine-generator set is operating at no-load, at maximum speed available with either air or steam at inlet at whatever pressure is available. Vacuum at exhaust is not required.
(c) Condition C. Turbine-generator set is operating at no-load, at rated speed with sufficient steam inlet and exhaust to obtain rated speed.
(d) Condition D. Turbine-generator set either idle or operating at load, speed, steam inlet and exhaust, as required to perform the test.
(e) Condition E. Turbine-generator set is operating at required load and speed with normal rated steam inlet and exhaust conditions (see 6.1.1) constant within the following limits:
    (1) Steam inlet pressure plus or minus 5 percent of absolute pressure.
    (2) Steam inlet temperature plus or minus 50°F.
    (3) Exhaust pressure plus or minus 1 psi or 2 inches Hg.
(f) Condition F. Turbine-generator set is operating at required load and speed with normal rated steam inlet and exhaust conditions (see 6.1.1) constant within the following limits:
    (1) Steam inlet pressure plus or minus 3 percent of absolute pressure.
    (2) Steam inlet temperature plus or minus 30°F.
    (3) Exhaust pressure plus or minus 0.05 psi or 2.5 percent of absolute pressure, whichever is larger.

4.4.4.2 Lubricating oil shall be of the type specified for the turbine (see MIL-T-24398).

4.4.4.3 The temperature of the water for the lube oil cooler and generator air cooler, if used, shall be maintained to within plus or minus 5 percent of 85°F, where test results depend on maintaining this temperature.

4.4.4.4 Tests may be combined where results obtained are the same as if each test was conducted separately.

4.4.4.5 Retest conditions. The occurrence of any failure as specified in 4.4.4.7 shall be cause to stop the test and reject the test item. The contractor shall determine the cause of failure and correct the deficiency. The contractor shall submit within 10 work-days, a corrective action plan to the contracting agency for acceptance. Rejection of the corrective action plan shall result in rejection of the test item. After the accepted correction has been taken, the contractor shall conduct a complete retest (or when accepted a lesser test) of the test item and no failures shall occur. After retest, the item shall be reinspected.

4.4.4.6 Design changes. The contracting agency accepted design changes or modifications made on the test item of a result of testing shall be incorporated or back-fitted on all equipments procured under the contract or order and shall be reflected in modified documentation and manuals to be submitted for acceptance by the contracting agency.

4.4.4.7 Failure. For purpose of tests, the occurrence of any of the following shall be considered a failure:

(a) Failure to meet any of the requirements of this specification.
(b) Any unscheduled forced shutdown.
(c) Damage of protective Government seals.
(d) Performance of any unauthorized maintenance during tests.
(e) Defective, damaged, broken or deformed parts.
(f) Excessive backlash or misalignment in gear trains.
(g) Measurable or noticeable gear wear.
(h) Pitting or galling of bearings or gears.
(i) Wear and wear rates which would possibly result in failure before the scheduled overhaul of subject part.

4.5 Inspection.

4.5.1 Examination. Each generator set shall be subjected to a thorough examination to ascertain that:

(a) Parts requiring servicing are conveniently available.
(b) Mounting of units, overall dimensions, location and size of pipe connections (particularly those to be completed by the activity installing the generator set), generator air gap and all clearances conform to drawing requirements.
(c) Bolting arrangements have adequate provision for installing and tightning bolts and nuts (particularly where units are shipped detached and are to be assembled by the activity installing the generator set).
(d) Bolts, nuts and other similar devices are tight and adequate provision has been made to prevent these items from becoming loose in service.
(e) The lube oil system including sumps, coolers, strainers, filters and bearing bracket reservoirs have been thoroughly cleaned of foreign material (dirt, metal chips, and so forth) and that surfaces exposed to oil have not been painted.

4.5.2 Air gap. The minimum air gap between the rotor and stator iron shall be carefully measured and recorded by means of suitable steel feelers or gages. The measurement shall be made at each end of the generator in at least six places, approximately 60 mechanical degrees apart, with one of the measurements obtained at the bottom. Where it is physically impossible to measure the air gap at six places on each end, measurements shall be obtained in as many places as practicable. If necessary, the generator shall be partially disassembled providing the relative position between the stationary and rotating elements is not disturbed. All air gaps shall be within 10 percent of the air gap design indicated on approved drawings.

4.5.3 Preliminary run. The turbine generator set shall be operated for at least 45 minutes at rated load or for a time which will bring the set up to or near its operating temperature. During this period, the general operation of the set shall be observed and any necessary adjustments shall be made.

4.5.4 Rated-load tests.

4.5.4.1 Four hour. Immediately following the test specified in 4.5.3, the generator set shall be operated at rated-load for 4-hours. At periodic intervals not greater than 15 minutes, the following data shall be recorded:

(a) Time.
(b) Ambient temperature.
(c) Temperature of water entering generator air cooler (if cooler furnished).
(d) Temperature of water leaving generator air cooler (if cooler furnished).
(e) Temperature of air entering generator air cooler (if cooler furnished).
(f) Temperature of air leaving generator air cooler (if cooler furnished).
(g) Quantity of water circulated in generator air cooler (if cooler furnished).
(h) Steam inlet pressure and temperature.
(i) Exhaust pressure.
(j) Lubricating oil pressure.
(k) Lubricating oil temperature to lube oil cooler.
(l) Lubricating oil temperature from lube oil cooler.
(m) Temperature of water entering lube oil cooler.
(n) Temperature of water leaving lube oil cooler.
(o) Quantity of water circulated in lube oil cooler.
(p) Generator, reduction gear (if gear furnished) and turbine bearing temperatures.
(q) Speed.
(r) Class A generator sets only:
    (1) Volts, line-to-line.
    (2) Volts, line-to-neutral (three wire sets).
    (3) Generator frame temperature.
    (4) Generator exhaust air temperature (where a generator air cooler is not furnished).
    (5) Current, line.
    (6) Current, neutral (three wire sets).
(s) Class B generator sets only:
    (1) Volts, line-to-line.
    (2) Current, line.
    (3) Generator and rotating exciter (if rotating exciter furnished) frame temperatures.
    (4) Generator (if generator air cooler not furnished) and rotating exciter

(if rotating exciter furnished) exhaust air temperature.
(5) Frequency.
(6) kW.
(7) Kilovoltampere (kVA).
(8) Pf.
(9) Excitation current and voltage.
(10) Stator coil temperature as observed from indicating devices.

4.5.4.2 One hour. This test shall be the same as specified in 4.5.4.1 except that the generator set shall be operated at rated-load for 1 hour.

4.5.5 Mechanical balance. The mechanical balance of the complete generator set shall be measured in the vertical and horizontal planes on the reduction gear (if furnished), the turbine and the generator bearing caps, or the associated shafts adjacent to these caps. Under no-load conditions, the vibration shall be continuously monitored during a non-stop run wherein speed is slowly increased from standstill up to 107 percent rated. Under rated load conditions, the vibration shall be monitored during a non-stop run wherein speed is slowly increased from 95 to 107 percent rated. The unit shall be run for at least 30 minutes at the start of the load test in order to stabilize readings. In addition, during both the no-load run at the rated-load run, vibration readings shall be taken and recorded at 1 percent speed intervals betwen the range of 95 percent to 107 percent rated. Results of these tests shall demonstrate conformance with 3.2.15.

4.5.6 Governor tests.

4.5.6.1 Where the governor system is of the electric speed and load sensing type, tests shall be conducted as required by MIL-G-21410.

4.5.6.2 Where the governor system is of the hydraulic relay, centrifugally controlled type, tests shall be conducted as follows:

(a) Load speed test.
(1) At no-load and with the generator excitation under the automatic control of the voltage regulator (on class A generator sets, generator excitation is to be manually controlled), the generator set speed shall be adjusted to 102 percent of rated speed.
(2) The load shall be changed in 5.0 percent increments from no-load to 100 percent and back to no-load. Where generator excitation is manually controlled, the voltage shall be adjusted to rated value at each load point. The speed and valve lifts shall be recorded for each load.
(3) The load speed curve shall be plotted, and two parallel lines having a droop in accordance with column 1 of table I and the kW spread in accordance with column 2 of table I shall be drawn to envelop the recorded points.
(4) Load-valve lift data and speed load curves shall be included in the test report.
(b) Speed fluctuation. At 0, 25, 75 and 100 percent continuous rated load, the periodic speed fluctuation shall be observed using an oscillograph or other similar recording device.
(c) Sudden load change.
(1) With the generator excitation automatically controlled by the voltage regulator (on class A sets, generator excitation shall be manually controlled) the generator set shall be operated at rated speed, voltage and at 80 percent rated kW load. A 70 percent rated kW load shall be suddenly removed in one step.
(2) With the generator excitation automatically controlled by the voltage regulator (on class A sets, generator excitation shall be manually controlled), the generator set shall be operated at rated speed and voltage. An 80 percent rated kW resistance load shall be suddenly applied in one step.
(d) Reading of overspeed, underspeed and recovery time shall be taken by means of an oscillograph or similar recording device. Sudden removal or application of load shall be accomplished by means of a circuit breaker installed between the load and the generator output terminals.

4.5.7 Voltage regulation tests.

4.5.7.1 Where electric speed and load sensing type governors are furnished with class B generator sets, oscillograph recordings of voltage shall be taken during the transient response tests required by MIL-G-21410 with the generator excitation automatically controlled by the voltage regulator.

4.5.7.2 Where hydraulic relay, centrifugally controlled type governors are furnished with class B generator sets, oscillograph recordings of voltage shall be taken during the tests specified in 4.5.6.2(c).

4.5.7.3 On class A generator sets, the voltage regulation test shall be conducted to determine conformance with 3.8.1.1.

4.5.8 Commutation.

4.5.8.1 During the voltage regulation tests on class A generator sets, the commutation shall be observed at each load point and when rated-load is applied or removed in one step. Commutation shall be as required by MIL-G-3111.

4.5.8.2 During the voltage regulation tests on class B generator sets and when 80 percent of rated-load is applied or removed in one step, the operation of brushes and slip rings shall be observed. There shall be no evidence of injurious sparking.

4.5.9 Rheostat tests. Rheostat tests shall be conducted with the generator fields hot and cold. These tests shall show that rheostats have the range of adjustment required by MIL-R-2729 on class B generator sets. Where these tests have been previously conducted in combination with the generator as required by MIL-R-2729, such tests need not be reported on the assembled generator set. Such tests shall demonstrate conformance with 3.6.4.1.2 when class A generator sets are furnished.

4.5.10 Effectiveness of enclosure. The enclosure tests shall be conducted as required by the applicable individual equipment specifications. Where these tests have been conducted by the equipment manufacturer, repeat tests need not be conducted on the generator set.

4.5.11 Lubrication. By careful observation and general examination of parts and by readings taken from temperature indicating devices, it shall be determined that lubrication is satisfactory and that oil does not leak past seals during the process of all tests including inclined operation tests. It shall be demonstrated that the limitations of bearing temperatures specified in the individual equipment specifications have not been exceeded. Bearing temperature limits do not apply during the mechanical balance test of 4.5.5.

4.5.12 Parallel operation tests. Unless otherwise specified (see 6.1.1), parallel operation tests shall be required. This test shall be conducted on the generator set being subjected to design or periodic inspection and a generator set of identical design. Where hydraulic relay, centrifugally controlled governors are furnished, the speed droop shall not exceed the maximum specified in column 3 of table I.

4.5.12.1 Class A generator sets. With each generator set operating as rated voltage and at a speed corresponding to approximately 20 percent load, the turbine governors and rheostats shall be adjusted for equal percentage division of load equal to approximately 20 percent of the combined kW rating of the paralleled generators. No further adjustments of the governor or rheostats shall be made for the duration of the test. The load shall be varied from 20 to 100 percent of the combined kW ratings of the two paralleled generator sets in four approximately equal steps and back to 20 percent load in the same manner. The speed, line current, kW load, field voltage and field current of each generator set at each load point shall be recorded.

4.5.12.2 Class B generator sets.

4.5.12.2.1 Where electric load and speed sensing governors are required, parallel operation tests shall be conducted in accordance with MIL-G-21410.

4.5.12.2.2 Where the governor system is of the hydraulic relay, centrifugally controlled type, paralleling tests shall be conducted by one of the following two methods:

(a) Simultaneous active and reactive power loading.
(b) Separate active and reactive power loading.

4.5.12.2.2.1 Simultaneous active and reactive loading. Simultaneous active and reactive loading shall be as follows:

(a) Parallel operation tests on generator sets shall be made with each generator connected to its intended prime mover and with the voltage regulator and exciter which are intended to be furnished with the generator set. With each generator set (complete with all attached and detached accessories) operating at rated voltage and at a speed corresponding to approximately

20 percent load, the governors and voltage regulator reactive droop compensation shall be adjusted for equal percentage division of load at rated pf of approximately 20 percent of the combined kW and kilovar (kvar) ratings of paralleled generator sets. No further adjustments of the governor, voltage regulator and rheostats shall be made for the duration of the test. The load shall be varied from 20 percent of the combined continuous kVA rating of the paralleled generators at approximately rated pf to 100 percent in four approximately equal steps and back to 20 percent load in the same manner. The speed, voltage, current, kW load, reactive kVA load, field voltage and field current of each generator shall be recorded for each load point.

(b) The kW pulsation of paralleled generators shall be measured at 25, 50, 75 and 100 percent of rated continuous load at rated pf. The kW pulsation is defined as the difference between maximum and minimum kW values that occur during a cycle of pulsation, expressed as a percentage of rated full load kW. The maximum and minimum values shall be determined by the pencil method using a wattmeter conforming to MIL-W-19088. To obtain the kW pulsation by this method, a generator set shall be operated in parallel with a generator set of the same design under conditions of steady load. The pointer on the wattmeter will be observed to oscillate through a small angle. Due to the damping of the meter, the pointer will indicate less than the true pulsation in kW. The cover over the scale on the meter shall be removed and a straight edge placed against the pointer. The pointer shall be moved slowly by the straight edge toward the maximum point of its swing until the pointer just perceptibly moves away from the straight edge. The pointer then reads the maximum value of kW during a cycle of the pulsation. The minimum value of kW shall be read similarly by placing the straight edge on the opposite side of the pointer and moving it toward the minimum point of its swing. The percent pulsation shall be:

$$\frac{\text{kW maximum} - \text{kW minimum}}{\text{kW rated}} \times 100$$

4.5.12.2.2.2 Separate active and reactive power loading. Separate active and reactive power loading shall be as follows:

(a) Separate active power loading tests shall be conducted with each generator connected to its intended prime mover and with the voltage regulator and exciter which are intended to be furnished with the generator set. With each generator set (complete with all attached and detached accessories) operating at rated voltage and at a speed corresponding to approximately 20 percent load, the governors and voltage regulators shall be adjusted for equal division of load (voltage regulator reactive droop compensation shall be inoperative) at approximately 20 percent of the combined kW ratings of paralleled generator sets. No further adjustments of the governor, voltage regulator and rheostats shall be made for the duration of the test. The load shall be varied from 20 percent of the combined continuous kW rating of the paralleled generators to 100 percent in four approximately equal steps and back to 20 percent in the same manner. The speed, voltage, current, kW load and field current of each generator at each load point shall be recorded.

(b) Following the tests specified in (a), the kW pulsation shall be measured as specified in 4.5.12.2.2.1(b) except that the load shall be at unity pf instead of 0.80 pf.

(c) Separate reactive power tests shall be conducted with each generator connected to any convenient prime mover and with the exciter and voltage regulator to be furnished with the generator unit. The voltage regulator reactive droop compensation shall be adjusted as required by MIL-R-2729. Parallel operation tests shall be conducted by loading the paralleled generators on another generator or using an impedance load at any convenient pf between 0 and 0.80 lagging. The load shall be varied over the range from no-load to 100 percent of the combined continuous kVA ratings of paralleled generators in five approximately equal steps and back to no-load in the same manner. At each load the frequency shall be adjusted to rated frequency and kW load, if any, balanced. At no-load, the frequency shall be varied from 5 percent below to 5 percent above rated frequency in approximately 1 percent steps to determine the circulating current. At each test point, the speed, voltage, current, kW load, reactive kVA load, field voltage and field current of each paralleled generator shall be recorded. (Note: The three phase currents of each paralleled generator may be used in lieu of reactive kVA in these tests

where the complete test is run at a load pf between zero and 0.1 lagging. When current is used in lieu of reactive kVA, the difference between the average of the three phase currents of one generator and that of the other generator at each load point shall be considered the reactive current differential for that point.)

4.5.13 Fifty hour test.

4.5.13.1 For class A and B generator sets. The first generator set of a particular design, type and size shall be operated for 50 hours in accordance with the following schedule:

(a) 20 hours at rated load.
(b) 30 hours at 60 percent rated load.

4.5.13.2 During these tests, data shall be recorded as specified in 4.5.4.1. The repair or replacement of any part of the generator set shall require a rerun of the test. The adjustment, repair or replacement of recording devices (such as meters, and so forth) may be accomplished provided such corrective action does not affect the validity of the test.

4.5.14 Inclination test. The generator set shall be operated at the rated operating speed, with or without load, for at least 30 minutes in each of the following four positions.

Position	Degrees
Shaft inclined, forward end down	5
Shaft inclined, forward end up	5
Shaft horizontal, base inclined to right	15
Shaft horizontal, base inclined to left	15

4.5.14.1 During the inclination test, the lubricating oil sump shall be filled to the maximum operating level. It shall be determined that mechanical balance is as good as it was in the horizontal position, that there is no pounding or grinding of bearings, that lubrication is satisfactory and there is no leakage of oil or water, particularly leakage of oil through the seals into the generator. Speed and speed fluctuations shall be observed in each of the positions by means of an oscillograph or similar recording device.

4.5.15 Weight and center-of-gravity. The generator set and all detached accessories shall be weighed dry. The operating weight of the generator set and any detached accessories, as applicable, shall be calculated using the dry weight and adding the weight of liquids which are used during normal operation of the generator set. The center-of-gravity for the generator set and all detached accessories weighing 100 pounds or more shall be determined for both the dry and operating condition.

4.5.16 Safety device test. All safety devices incorporated in the generator set shall be tested in accordance with the following to demonstrate their effectiveness:

(a) Overspeed trips at least five times.
(b) Back pressure trips at least twice.
(c) Relief valves at least twice.
(d) All other devices at least twice.

The speed, pressure, back pressure, and so forth, at which each safety device operates shall be recorded for each test conducted.

4.5.17 Shock tests.

4.5.17.1 Generator sets shall be tested in accordance with the requirements for grade A, class I of MIL-S-901. Where resilient mounting of equipment is required, generator sets shock tests shall be conducted in accordance with the requirements for grade A, class II of MIL-S-901.

4.5.17.2 Intended function. The intended function of a shockproof generator set is to continuously deliver electrical power in accordance with the performance requirements specified herein during and after being subjected to the shock of the magnitude specified in MIL-S-901. Further, a shockproof generator set, when subjected to shock, shall not suffer damage to the extent that it creates a possible hazardous situation such as fire or injury to personnel or such as to result in likely failure of major units if the set is not immediately shut down for corrective action to prevent such failure.

4.5.17.3 Acceptance of generator set. Acceptance of generator set and accessory designs which have been subjected to shock tests shall be based on the ability of equipment to meet the requirements of 4.5.17.2 and the following:

(a) Where no damage is revealed during shock tests or during the post-shock test factory inspection required by 4.5.17.10 and 4.5.17.11, the design will be acceptable provided the reassembled equipment meets the requirements of 4.5.17.13(e).
(b) Where damage is revealed during shock tests or during the post-shock test factory inspection required by 4.5.17.10 and 4.5.17.11, acceptance will be based on NAVSEC approval of corrective action proposed by the supplier.

4.5.17.4 Method of test. Method of test shall be as follows:

(a) All required performance tests shall be satisfactorily completed prior to shock testing.
(b) The generator set package, for example, prime mover, reduction gear (if used), generator, exciter (if attached), subbase, condenser (if furnished), air ejector (if furnished), heat exchanger and all attached accessories and any other detached accessories needed to control and operate the set during shock tests shall be tested as a principal unit. Other detached accessories may be tested along with the generator set package if the weight, size and arrangement limitation of the test machine is not exceeded. Detached accessories not tested with the generator set package shall be individually tested using the applicable shock testing machine referenced in MIL-S-901 and in accordance with the individual equipment specification applicable to the accessory.
(c) As a minimum, the following data on the generator set scheduled for shock tests shall be recorded at the factory prior to shipment of the set for shock tests.
(1) Turbine shroud, oil seal, blade and nozzle clearances.
(2) Turbine rotor thrust and total end travel clearances.
(3) Bearing clearances.
(4) Side play of diaphragms at crush pin location clearances.
(5) Turbine, reduction gear (if used) and generator bearing shell thickness.
(6) Turbine rotor recorded unbalance in balancing machine.
(7) Turbine rotor run out in several locations.
(8) All journal diameters.
(9) Turbine and pinion (if used) alinement.
(10) Gear (if used) and generator alinement.
(11) Generator and rotating exciter (if rotating exciter used) alinement.
(12) Backlash between pinion and gear (if pinion and gear used).
(13) Oil pump drive alinement.
(14) Governor drive alinement.
(15) Generator rotor and reduction gear (if reduction gear used) run out at several locations.
(16) Generator rotor and gear (if gear used) recorded unbalance in balancing machine.
(17) Dielectric tests on generator rotor and stator.
(18) Dielectric tests in rotating exciter (if rotating exciter used).
(19) Air gap measurements of generator and rotating exciter (if used).
(20) Dielectric tests on all other electrical equipment to be shock tested along with the generator set package.
(21) Rotating exciter (if rotating exciter used) recorded unbalance in balancing machine.

4.5.17.5 Mounting of equipment on floating shock test platform. The mounting of equipment on floating shock test platform shall be as follows:

(a) The generator set package shall be mounted on a foundation welded to the inner deck of the floating test platform. This foundation shall be designed to simulate a typical shipboard foundation characteristic as closely as possible.
(b) Deck mounted detached accessories, if tested with the generator set package, shall be mounted on a fixture designed to accommodate the accessory and welded to the inner deck.
(c) Bulkhead mounted detached accessories, if tested with the generator set package, shall be mounted on a fixture designed to accommodate the accessory and welded to the side of the floating shock test platform.

4.5.17.6 Test procedure. Shock tests shall be conducted in accordance with MIL-S-901 and as specified in 4.5.17.6.1 through 4.5.17.6.7.

4.5.17.6.1 The generator set shall be rotated at no-load during each blow or shot at a speed as close to maximum rated speed as possible by means of clean dry compressed air supplied to the turbine throttle valve. To prevent icing in the turbine steam path, air shall not be supplied at a pressure higher than 100 psig and operating time shall not exceed 10 minutes per 2 hour period.

4.5.17.6.2 All units and accessories, attached or detached, which contain a fluid during normal operation (such as generator air coolers, condensers, air ejectors, lube oil coolers and so forth) shall contain a fluid of comparable weight during all blows or shots.

4.5.17.6.3 All subassemblies associated with the trip throttle valves shall be connected and activated during the test.

4.5.17.6.4 Lubricating and control oil of the type and quantity specified by the manufacturer of the generator set shall be supplied to the equipment during operation. The manufacturer's recommended limits for oil pressure, temperature and cleanliness shall be observed. If the generator set tested possesses a completely self contained oil system, this system shall be used if satisfactory oil pressures can be maintained by it, at all equipment speeds, without the use of hand-driven pumps. If the oil system furnished does not meet the requirements herein, oil shall be supplied to the equipment by an auxiliary oil system furnished by the shock testing facility. As necessary, this system shall include an oil pump of proper rating, oil pressure control apparatus, oil strainer, oil pressure and temperature gages, a sump of sufficient capacity and appropriate piping. The auxiliary oil system shall be connected to the generator set oil system as recommended by the generator set manufacturer. If necessary, provision shall be made for heating the oil to the minimum temperature required for equipment operation.

4.5.17.6.5 Gland steam and leakoff connections on turbines shall be blanked off, as necessary, to maximize the amount of compressed air reaching the turbine blades. The steam side of auxiliary condensers shall be vented to atmosphere, if necessary, to permit free escape of turbine exhaust air.

4.5.17.6.6 Unless otherwise specified herein, equipment shall be tested in such a manner that the most adverse situations for shock are represented during the test. For example, if a valve stem is more likely to fail under shock when the valve is nearly wide open, it should be tested in this position, other considerations permitting.

4.5.17.6.7 Provision shall be made by the shock testing facility for remote observation of lubricating oil pressure during periods when the generator set is unattanded. Provision shall also be made for remote emergency shutdown of the air supply to the turbine throttle valve. The air supply shall be secured from the remote station at the instant the explosive charge is detonated.

4.5.17.7 Examination. As a minimum, the examination specified in 4.5.17.7.1 through 4.5.17.7.4 should be accomplished at the shock test facility.

4.5.17.7.1 Examination at the shock testing activity. Upon receipt of equipment at the shock facility it shall be examined for any sign of damage during shipment. Any apparent damage shall be reported in detail to the generator set manufacturer for appropriate corrective action. All disassembly and internal examination of generator sets shall be conducted under the guidance of the manufacturer's representative.

4.5.17.7.2 During shock tests, the following examination shall be accomplished before each blow or shot:

(a) The equipment shall be rotated by hand to check for signs of damage associated with moving parts, such as rubs, noise and increased friction. If no sign of damage that would preclude safe operation of the equipment is revealed, and upon concurrence by the generator set manufacturer's representative, the generator set shall be rotated by means of compressed air while close attention is given to detecting any sign of damage or malfunction. Record the vibration levels of the generator set while operating with compressed air.

(b) Permanent shock induced misalinement or offset between accessible parts connected by or alined by bolts, keys or other means shall be noted and measured at all locations where maintenance of correct alinement is of significant importance. To accomplish this, punch marks scribed lines or

measurements (as appropriate for the accuracy required) shall be used to establish the relative location of such parts before tests. Any deviation from the pretest status shall be measured and recorded.

(c) All accessible bolts and dowels shall be checked for any sign of looseness. The location and function of each loosened bolt and dowel and the number or fraction of turns required to tighten the bolts shall be recorded, where excessive yielding of bolts is experienced, the bolts shall be replaced by higher strength types before proceeding to the next blow or shot. All bolts shall be tightened or secured before proceeding to the next blow or shot.

(d) A thorough visual examination of all accessible items shall be accomplished. All examination covers and generator upper-half end shields, as applicable, shall be removed to examine internals. Steam-tight joints need not be separated for this examination. Any evidence of distortion, impact, rubbing, leaks, excessive wear, weld cracking or unwarrented relative motion shall be recorded and documented with respect to its location, nature, cause and effect.

(e) Turbine, gear and generator thrust bearing axial clearance, as applicable, shall be measured. Where this measurement indicates that the clearance has changed, the turbine nozzle clearance (minimum) and the total rotor axial clearance (rotor float) with thrust bearing shoes removed shall be measured. (Note: The angular position of the shaft shall be recorded when the pretest measurement is taken. The shaft shall be turned to this position for repeat measurements taken during the shock test. Measurement accuracy shall be within plus or minus 0.002 inch.)

(f) Generator and exciter (if rotating exciter is used) air gap measurements shall be taken. The angular position of rotating elements shall be recorded when the pretest measurement is taken. The rotating elements shall be turned to this position for repeat measurements taken during the shock test. Measurement accuracy shall be within plus or minus 0.005 inch.

(g) All turbine throttle valve tripping devices and actuating means shall be activated before each blow or shot, and the throttle valve opened. After each shot, it shall be verified that shock induced tripout did not occur and that all tripping devices operate properly. Tests of overspeed trips at the tripping speed are not required if the generator speed cannot be run up to tripping speed on compressed air.

(h) Measurements shall be taken to determine whether the magnitude of generator brush bounce during each shot will cause opening and closing of the generator field circuit.

(i) Where failures are experienced during a shot, particularly minor failures which can be conveniently corrected at the test site, corrective action shall be taken and proven on the next shot. For example, where equipment experiences a failure during shot 4, corrective action shall be taken and proven during shot 5. Where equipment experiences a failure during shot 5, corrective action shall be taken and proven by an additonal shot which shall be a repeat of shot 5.

4.5.17.7.3 Before and after the series of shots, the following examination shall be made.

(a) Angular alinement between reduction gear and pinion teeth shall be determined. Blue transfer methods are preferred, but tooth spacing measurements may be employed for this purpose.

(b) Runout of principal rotating parts, and facial and peripheral alinement between principal rotating parts, shall be determined.

(c) Watersides of all coolers and condensers associated with the generator set package shall be hydrostatically tested to the levels specified on vendors drawings.

(d) Insulation resistance measurements shall be taken and dielectric strength tests shall be conducted on all electrical equipment tested with the generator set package. These tests shall be conducted as required by the individual electrical equipment specifications.

4.5.17.7.4 Additional examination may be conducted as deemed necessary by the generator set manufacturer.

4.5.17.8 General requirements. General requirements shall be as follows:

(a) The shock facility shall prepare for and conduct tests based on the requirements specified herein. Where the detailed requirements presented herein are not applicable to the item of equipment being tested, the generator set

manufacturer or the test facility shall formulate detailed inspection procedures based on the requirements of MIL-S-901 and the applicable individual specification. Where detailed requirements for shock tests are not shown in the applicable individual equipment specification, detail test and inspection requirements shall be formulated by the generator set manufacturer or the test facility and shall be reviewed by NAVSEC prior to conducting shock tests. Modification of shock test procedures contained herein, whether recommended by the generator set manufacturer or the test facility, shall also require NAVSEC review. Otherwise, NAVSEC review of routine plans and procedures for shock tests will not be required. Where resilient mounted equipment is shock tested and mounts are of the Navy Standard type, such mounts will be supplied by NAVSEC for tests and retained by the shock test activity. Where mounts are not of the Navy Standard type, such mounts shall be furnished by the generator set manufacturer. Two copies of detail test and examination requirements shall be forwarded to the activity procuring the generator set, two copies forwarded to NAVSEC for review and one copy forwarded to Supervisor of Shipbuilding, New York, and one copy to the U.S. Navy Ships, R and D Center (UERD), Portsmouth, Virginia and one copy to Hunter Point Naval Shipyard, San Francisco, California.

(b) The generator set manufacturer shall furnish technical assistance to the shock testing activity in the formulation of test and examination procedures, operation and installation of the generator set, inspections to be required at the test site and shock test instrumentation.

(c) The activity procuring the generator set and NAVSEC shall be notified at least 30 days in advance of scheduled shock tests so that arrangements can be made to witness the tests and attendant inspections if desired. Such a notice shall be accompanied by a copy of the completed equipment data sheet (see figure 6).

(d) Within 30 days after completion of shock tests, the generator set manufacturer shall furnish a preliminary report containing the following information to the activity procuring the generator set with one copy each to NAVSEC and the Supervisor of Shipbuilding, New York.
  (1) Identification of equipment involved.
  (2) Details regarding cause, nature, extent and effect of all known or suspected damage observed at the test facility. Photographs of damage, if available, shall be included.
  (3) Details regarding any equipment nalfunctions during tests.

(e) A final detailed report shall be furnished by the generator set manufacturer in accordance with 4.5.17.12.

4.5.17.9 Shock test instrumentation. Standard instrumentation for heavy weight equipment shock tests shall consist of one or more velocity transducers mounted on the floating shock platform deck to permit documentation of shock inputs. The generator set manufacturer shall determine the number and locationof transducers to be used for this purpose. Generator set manufacturers desiring that additional instrumentation be used to document equipment motion or other shock induced equipment reactions should contact the test facility as far in advance of tests as possible. Although the use (or extent of use) of additional instrumentation is subject to shock facility limitations, such facilities can generally furnish transducers with appropriate readout devices for remote measurement of velocity, acceleration, vibration, strain, voltage, rpm and pressure. However, the number of information channels may be limited to ten or less at some shock facilities. High speed motion picture cameras are usually available.

4.5.17.10 After completion of shock tests and recording of data as required herein, the generator set package and any detached accessories tested along with the package shall be returned to the generator set manufacturer's plant for tests, complete teardown and examination in accordance with the following:

(a) The equipment shall be given a visual examination to assure that no damage has occurred during shipment.

(b) The equipment shall be given a post shock operating test as follows:
  (1) The examination covers of all units shall be removed, units examined and any other examination such as alinement shall be accomplished, as necessary, to determine the operativeness of the generator set.
  (2) If such examination reveals no damage which would prohibit full power operation, the generator set with detached units shall be installed on a test stand and continuously operated at rated load and at rated speed for 4 hours. Data as required by 4.5.4 shall be taken and recorded.

4.5.17.11 Upon completion of the test required by 4.5.17.10, the generator set units shall be disassembled part by part, making visual examination and dimensional checks of parts and clearances, as necessary, recording damage, evidence of shifting, rubbing, momentary contact, and so forth. The minimum detail examination shall be as follows:

(a) Lift the turbine cylinder cover. Record indications of rubs, cracks and internal damage on shrouds, seals, blades and rotor.
(b) Lift turbine bearing caps. Record indications of rubs and cracks.
(c) Measure turbine spindle thrust clearance, total end travel and thrust bearing filler ring sizes.
(d) Measure turbine shroud clearances to diaphragm and seal ring clearances.
(e) Place turbine spindle in lathe and check the following:
  (1) Runouts in several locations.
  (2) Journal out of roundness.
  (3) Measure journal diameters.
(f) Place turbine spindle in balancing machine and record unbalance.
(g) Check looseness of turbine thrust collar.
(h) Check concentricity of bearing housing bores to gland bores and the following:
  (1) Check for signs of joint slippage.
  (2) Check dowels for deformation.
(i) Check each turbine diaphragm in cylinder cover and base for amount of end play.
(j) Remove steam chest cover and examine for damage to valves and attached linkage.
(k) Check throttle valve operation using oil at the normal operating pressure.
(l) Check turbine supports for possible shifting of bolts at the cylinder connection.
(m) Check overspeed trip, body and parts for damaged items.
(n) Remove gear cover. Record indications of rub, cracks and any internal damage.
(o) Disassemble pinion and examine spigot fit and fitted bolts for damage.
(p) Record pinion and gear backlash. Also check teeth for damage.
(q) Place pinion and gear in lathe and check the following:
  (1) Runouts in at least three locations.
  (2) Measure journal out-of-roundness.
  (3) Measure journal diameters.
(r) Place pinion in balancing machine and record unbalance.
(s) Place gear and generator rotor in balancing machine and record unbalance. If gear and generator rotor originally balanced as separate items, they may be placed in balancing machine as separate items in lieu of one assembly.
(t) Remove governor and check internal parts for damage.
(u) Remove oil pump or pumps and check internal parts for damage. Check oil pump drive shafts for runout.
(v) Disassemble steam valve operator and examine for damage.
(w) Check generator end bells and rotating exciter end bells (if rotating exciter used) for joint slippage. Check any dowels for deformation.
(x) Check generator collector ring assembly for damage if collector rings used.
(y) Check commutator of rotating exciter (if used) for damage.
(z) Check generator and rotating exciter (if used) brush rigging assembly (including terminal leads, brushes and brushholders) for damage and slippage.
(aa) Check generator and rotating exciter (if used) air gaps.
(bb) Remove generator and rotating exciter (if used) rotating assemblies and accomplish the following checks:
  (1) Runouts at several locations.
  (2) Journal out-of-roundness.
  (3) Journal diameters.
  (4) Blower arrangement.
  (5) Damage to and movement of windings, poles, and coil braces.
(cc) Check generator, rotating exciter (if used) and bearings pedestal (if applicable) foot welds for damage and check bolts which attach these items to the bedplate for distortion and elongation.
(dd) Remove cover of generator and examine excitation system rectifier arrangement for damage (if this arrangement is mounted in the generator).
(ee) Check generator air cooler (if used) for damage and movement. Also examine cooler holddown bolts for distortion and elongation. Subject the cooler to a hydrotest and examine for leaks.
(ff) Check condenser, air ejector and aftergland condenser (if furnished) bolting for tightness and joint slippage.
(gg) Subject the condenser to a hydrotest and examine for leaks.

(hh) Check all supporting structures for deformation and for damage to welds.
(ii) Conduct dielectric tests on the generator and rotating exciter (if used).
(jj) Detached accessories which are shock tested along with the generator set shall be subjected to an examination to determine the extent of damage, if any. Where electrical items are involved, they shall be subjected to a dielectric test after completion of the examination. Such test shall be conducted as required by the individual equipment specification covering the item.
(kk) All welds shall be examined and those suspected of deformation shall be checked using any applicable non-destructive test.

4.5.17.12 A detailed report on the shock tests and on post shock test factory examination and tests shall be prepared. Two copies of this report shall be forwarded to the activity procuring the generator and to NAVSEC and one copy to SUPSHIP, New York. The report shall include the following:

(a) Results of the post shock test factory examination and tests in detail. These results shall show a comparison of measurements made prior to the shock test and those taken during the post shock test factory examination and tests.
(b) Photographs to show the extent of damage to parts and relative movement of parts where examination reveals damage or movement.
(c) The generator set manufacturer's recommendations for design improvements to "shock harden" the equipment.

4.5.17.13 Disposition of shock tested equipment. Unless otherwise specified in individual equipment specifications, shock tested equipment will be acceptable for delivery under the contract or order provided the following requirements are met:

(a) All minor damage resulting from shock tests is corrected. Minor damage is defined as that which will not result in nonconformance with 4.5.17.3.
(b) All major damage resulting from shock tests is corrected by redesign. Major damage is defined as that which will result in nonconformance with 4.5.17.3.
(c) All bearings shall be replaced where examination reveals minor damage. Where major damage if discovered, appropriate redesign action shall be taken.
(d) Any design improvements necessary to "shock harden" the equipment are incorporated in the generator set.
(e) The reassembled equipment is given the routine inspection as specified herein for generator sets. Results of tests shall show conformance with specification performance requirements and shall be consistent with the results of tests conducted on other identical units.

4.5.18 Noise tests.

4.5.18.1 Where special noise reduction limitations are not applicable, airborne noise tests shall be conducted to determine conformance with 3.2.17.1. Measurements of airborne noise shall be made on the completely assembled generator set as follows:

(a) Under no-load and rated-load conditions.
(b) Tests shall be conducted in the factory when the ambient noise is at a minimum.
(c) With the generator set rigidly mounted.
(d) With a calibrated sound level meter and octane band filter set conforming to ANSI S1.4-1971 and S1.11-1971 and a pressure sensitive microphone.
(e) The microphone shall be placed at a distance of 3-feet from the nearest surface of the generator set in each of the following positions:
  (1) Midway between the ends of the generator set and on each side at the same height as the equipment horizontal centerline. Where reduction gear is furnished, the location shall be at each side at the same height as the reduction gear horizontal centerline and opposite the point where the gear horizontal and vertical centerlines intersect.
  (2) At the generator end along the generator centerline end of the turbine and along the turine centerline.
  (3) Above the equipment midway between the ends of the generator set, where reduction gear is furnished, the location shall be along the vertical centerline of the reduction gear.

4.5.18.2 Where special noise reduction limitations are applicable (see 3.2.17.2) and are specified (see 6.1.1), the requirements for conducting airborne and structureborne noise tests shall be as specified (see 6.1.1).

4.5.19 Steam consumption test. Generator set steam consumption shall be measured at 100, 60 and 40 percent load.

4.5.20 Special environmental vibration test. Where vibration tests, other than those specified in individual equipment specifications are required, the units to be tested and the requirements for test shall be specified (see 6.1.1).

4.5.21 Post test examination. The following examination shall be accomplished after completion of all tests on each generator set.

(a) Examine all journals for scoring.
(b) Examine all bearings for damage.
(c) Verify proper assembly of seals and examine for condition.
(d) Examine reduction gear (if reduction gear furnished) to determine that tooth contact is adequate.

4.5.22 Maintainability demonstration test. A maintainability demonstration test shall be conducted to verify achievement of the quantitative value of predicted maintainability specified in 3.2.3.7 and 3.2.3.10. The demonstration shall be conducted in accordance with MIL-STD-471 (see 6.5) except as modified herein.

4.5.22.1 A demonstration plan shall be submitted by the turbine generator manufacturer to NAVSEC for review and acceptance. This plan shall be formulated so that it will apply to a basic design or designs and any known modifications thereto. Once this plan has been accepted it shall be used on generator sets furnished under this specification except where a new basic design or modifications to the original basic designs have been incorporated in generator sets and are not covered by the original plan. In this case, the generator set manufacturer shall submit a demonstration plan for the new basic design or the modification, as applicable, to NAVSEC for acceptance. As a minimum the following items shall be covered in the demonstration plan.

(a) Preventative maintenance tasks shown on figure 1.
(b) Corrective maintenance tasks as follows:
  (1) Replacement of journal bearings.
  (2) Replacement of seals.
  (3) Replacement of thrust bearings.
  (4) Replacement of parts in the overspeed trip assembly, the bearing low lube oil pressure trip assembly and the back pressure trip assembly.
  (5) Replacement of parts in the turbine driven lube oil pump and drive assembly.
  (6) Replacement of parts in the throttle valve.
  (7) Replacement of parts in the gland seal regulator.
  (8) Replacement of all recording devices (thermometers, gages, and so forth) mounted on the generator set package. Also check accessibility of these devices to verify that readings can be easily observed by operating personnel.
  (9) Replacement of governor parts.
  (10) Replacement of generator brushholders, springs and brushes. This requirement also applies to rotating type exciters where furnished.
  (11) Replacement of generator heaters, where furnished.
  (12) Check accessibility of terminals and terminal boards to verify that wiring to these boards can be conveniently disconnected and connected by maintenance personnel without removing units or parts on the generator set other than removal of access covers for these terminals and terminal boards.
  (13) Replacement of parts in the voltage regulator.
  (14) Replacement of parts in the static type exciter, where furnished.
  (15) Replacement of resistance temperature sensing elements (RTD's).

4.5.22.2 Maintainability test conditions. The maintainability test shall be performed with the equipment or system installed in a manner which simulates, to the satisfaction of the procuring activity, an actual shipboard installation and the access envelope (see 3.2.5) shall be simulated with panels and screens. Test equipment, tools, repair parts and maintenance literature, at least in the form of preliminary manuscripts of manuals covering maintenance instructions shall be made available for the performance of the tests. Test team, facilities and support material shall represent the normal shipboard resources as defined in the manuals prepared for this equipment. Panels or screens shall surround it to

simulate the shipboard access envelope. Test mechanics shall be given no outside assistance. The following shall be recorded, monitored or certified by the contracting agency's representative during the test:

(a) Data collected, including man-hours, clock-hours, maximum number of active mechanics, part identification, documentation of the specified maintenance tasks (see 4.5.22.1).
(b) Factors which influenced the data.
(c) Identification of other intervening parts removed or moved to replace the part for which a replacement time has to be demonstrated.
(d) Computation or measurement of the required replacement times.
(e) Deficiencies.
(f) Recommendations.
(g) Results of retest, if applicable.
(h) Certification by a contracting agency's representative of the data obtained and whether or not the replacement time requirements have been met.

4.5.22.3 The timing and skill levels of manufacturer's shop personnel who perform the maintenance tasks of the demonstration test shall be commensurate with Navy personnel who will maintain the generator set.

4.5.22.4 Simulation of faults or failures by introducing defective parts is not required.

4.5.22.5 The activity procuring the generator set and NAVSEC shall be notified at least 30 days in advance of scheduled maintainability demonstration tests so that arrangements can be made to witness the demonstration if desired. Such notice shall contain complete identification of the equipment involved.

4.6 Inspection of preparation for delivery. The packaging, packing and marking shall be inspected for compliance with section 5 of this specification.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.3.)

5.1 General requirements.

5.1.1 Packaging technical data (see 6.1.2). Technical data depicting the packaging, packing and marking; packaging and transportation; and imports of the preservation-packaging and packing test(s) shall be prepared by the contractor and submitted to the procuring contracting office (PCO), via the technical packaging element of the administrating contract office (ACO).

5.1.1.1 Previous submittal. Data submitted under 5.1.1 herein on previously procured identical equipment and parts for evaluation is not required.

5.1.2 Disassembly.

5.1.2.1 Disassembly for cleaning and preservation. Equipment disassembly shall be the minimum necessary to make accessible for cleaning and preservation of all machined or critical internal surfaces.

5.1.2.2 Disassembly for shipment. Removal of secondary assemblies, accessories or projecting parts which will facilitate equipment protection from damage, pilferage and loss, or reduction of cube is permitted where such removal will not effect permanent settings or alinements and where the removed parts can be readily reassembled at the installation side without the need for special tools or gages. Removed hardware (bolts, nuts, pins, screws, washers and others) shall be reinstalled in mating parts and secured to prevent their loss. Detached components shall be packaged and included within the same container as the basic unit except where the minimum care weight and cube are adversely affected, they shall be packed separately.

5.1.3 Matchmarking. Removed parts of the equipment shall be matchmarked to facilitate reassembly. Removed parts shall be tagged with cloth shipping tags. Tags shall also be attached to each mating part. The tags and printing thereon shall be resistant to water, oil and fading.

5.2 Preservation-packaging. Preservation-packaging shall be level A or C as specified (see 6.1.1).

5.2.1 Turbine generator set.

5.2.1.1 Level A. Preservation-packaging, level A, shall be as follows:

(a) Turbine, gears and couplings shall be preserved-packaged in accordance with the level A requirements of MIL-P-17286, except that the steam side of the turbine shall be preserved with grade 5 of MIL-C-16173. All turbines shall have the steam side preservation identified by a tag stating "STEAM SIDE PRESERVED WITH (Mfr. name and type and specification of preservative)".
(b) Generators and other electrical units shall be preserved-packaged in accordance with the level A requirements of MIL-E-16298 or MIL-E-17555, as applicable. When the size and mounting arrangement of the generator does not permit enclosure of the generator within a waterproof barrier, the alternate method of packaging specified in MIL-E-16298 may be applied.
(c) Condensers, air ejectors and coolers shall be preserved-packaged in accordance with the level A requirements of the applicable individual equipment specification.
(d) Pumps shall be preserved-packaged in accordance with the level A requirements of MIL-P-16789.
(e) Instrumentation such as gages and thermometers shall be preserved-packaged in accordance with the level A requirements of the applicable individual equipment specification.

5.2.1.1.1 Reusable flexible containers. When specified (see 6.1.1), a reusable flexible container conforming to type III of MIL-C-9959 with exceptions thereto (see 5.2.1.1.1.1) shall be used in lieu of MIL-B-131 barrier material for method II protection.

5.2.1.1.1.1 Unless otherwise specified (see 6.1.1) the following exceptions are applicable to MIL-C-9959.

(a) The following requirements are not applicable:
  (1) Pressure relief valve.
  (2) Closure protective cover.
  (3) Desiccant receptables.
  (4) Protection period.
  (5) Handling and compatibility.
  (6) Mobility.
  (7) Rough handling.
  (8) Wind resistance.
(b) Tables I and II, column 2, opposite "Fluid resistance" add "MIL-L-3150, MIL-C-16173 and MIL-L-21260".
(c) Paragraph 3.2.3 "The container color shall be at the suppliers option".
(d) Paragraph 3.3.1 "The standard drawings of the container supplier will be acceptable".
(e) Paragraph 3.7: Delete "Relief Valve, Do Not Disturb" and "Open Closure when air transported".
(f) Section 4: "In addition to the tests of 4.5 of MIL-C-9959 the equipment manufacturer upon installation of the container on the equipment shall repeat the pressure retention test or may apply the vacuum retention test (reduced to 2-inches of water, maintained for a period of 1-hour) of MIL-P-116. Upon completion of all testing, as much air as possible should be extracted from the container. (This additional test will assure closure reliability and that no damage (pin holes, minute tears, etc.) or closure deformation occurred from the time of container manufacturer, or during installation by the equipment manufacturer)."

Desiccant shall be uniformly distributed throughout the container to permit optimum effectiveness. Desiccant bags shall be secured in a manner to prevent contact with the enclosed item.

5.2.1.2 Level C. Preservation-packaging of turbine generator sets shall afford protection against corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. The suppliers normal retail or wholesale preservation-packaging methods may be utilized when such meet the requirements of this level.

5.3 Packing. Packing shall be level A, B or C as specified (see 6.1.1).

5.3.1 Levels A and B.

5.3.1.1 Generator sets-assembled (see 6.2.2).

5.3.1.1.1 Sets 30,000 pounds or less. Each generator set weighing 30,000 pounds or less, preserved-packaged as specified (see 5.2), shall be packed for shipment in a crate conforming to MIL-C-104 and the appendix thereto. The class, type and style selection shall be at the option of the contractor. Anchoring, blocking and bracing of the crate contents shall be in accordance with MIL-STD-1186 and the appendix to MIL-C-104.

5.3.1.1.1.1 Instrumentation and accessories such as gages and thermometers shall be removed from the generator set, preserved-packaged as specified in 5.2 and packed in a container in accordance with the level A or B requirements of MIL-P-17286 as specified.

5.3.1.1.1.2 Accessories and units furnished as detached items, preserved-packaged as specified (see 5.2), shall be packed in accordance with the level A or B requirements as specified of the applicable individual equipment specification.

5.3.1.1.2 Sets over 30,000 pounds. Each generator set over 30,000 pounds shall be packed as specified in 5.3.1.1.1, except that the base and skid system shall conform to the design requirements of the U.S. Department of Agriculture Handbook No. 252.

5.3.1.2 Generator sets-disassembled (see 6.2.3). The disassembled items and equipment shall be packed level A or B as specified in accordance with the requirements of the applicable individual equipment specification. Individual items exceeding 30,000 pounds shall be packed as specified in 5.3.1.1.2.

5.3.2 Level C. Packing shall be accomplished in a manner which will afford protection against damage during shipment from the supply source to the using activity for early installation. Containers, packing, or method of shipment shall comply with Uniform Freight or National Motor Freight Classification Rules or Regulations or other carrier rules as applicable to the mode of transportation.

5.4 Marking.

5.4.1 Standard marking. In addition to any special marking required herein or by the contract or order (see 6.1.1), unit and intermediate packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

5.4.2 Special marking. Handling and structural markings as applicable shall be applied (see MIL-STD-129 and the appendix to MIL-C-104). In addition, shipping containers for equipment shall be stenciled as follows:

"CAUTION - THIS EQUIPMENT MAY BE DAMAGED UNLESS UNPACKING INSTRUCTIONS ARE CAREFULLY FOLLOWED. UNPACKING INSTRUCTIONS ARE LOCATED (state where located)."

Where practical, this marking shall be applied adjacent to the identification marking on the side of the container.

5.5 Unpacking instructions. Unpacking instructions for equipment, assembled or disassembled generator sets, shall be provided to prevent possible damage during removal from the shipping container. When practicable, one set of these instructions shall be placed in a sealed waterproof envelop prominately marked "Unpacking Instructions" and securely attached to the outside of the shipping container in a protected location. If the instructions cover a set of equipment packed in multiple containers, the instructions shall be attached to the number one container of the set.

5.6 Repair parts and special tools. Repair parts and special tools shall be preserved-packaged level A or C, packed level A, B or C as specified (see 6.1.1) and marked in accordance with MIL-P-17286 or MIL-E-17555 as applicable.

5.6.1 Repair parts shall be packed separately and unless otherwise specified (see 6.1.1) shipped concurrently with the basic equipment.

5.7 Technical manuals. Technical manuals which accompany shipments that are packed level A or B, shall be packaged in a transparent waterproof plastic bag, minimum 4 mil thick. Closure shall be by heat sealing. Technical manuals shall not be placed within any sealed flexible barrier enclosing components. The copy(s) of the manual shall be placed in the shipping container housing the main unit. Packing lists shall indicate which container contains the technical manual(s) and shall also state the approximate location therein. For ease of removeability the location of the manual shall be such that it is readily accessible when the container is opened. Technical manuals, when shipped in bulk quantities, shall not be individually wrapped, but shall be packed in accordance with the requirements of the applicable technical manual specification or packed in containers conforming to the requirements of level A, B or C as specified (see 6.1.1).

5.8 Drawings and microfilm. Drawings and microfilm shall be prepared for shipment in accordance with the applicable drawing or microfilm specification.

5.9 Use of polystyrene (loose-fill) material.

5.9.1 For domestic shipment and early equipment installation and level C packaging and packing. Unless otherwise authorized by the procuring activity (see 6.1.1), use of polystyrene (loose-fill) material for domestic shipment and early equipment installation and level C packaging and packing applications such as cushioning, filler and dunnage is prohibited. When approved, unit packages and containers (interior and exterior) shall be marked and labelled as follows:

"CAUTION

Contents cushioned etc. with polystyrene (loose-fill) material.
Not to be taken on board ship.
Remove and discard loose-fill material before shipboard storage.
If required, recushion with cellulosic material bound fiber,
fiberboard or transparent flexible cellular material."

5.9.2 For level A packaging and level A and B packing. Use of polystyrene (loose-fill) material is prohibited for level A and B packing applications such as cushions, filler and dunnage.

6. NOTES

6.1 Ordering data.

6.1.1 Procurement requirements. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Type and class of generator set required (see 1.2).
(c) Accessories to be detached from generator set (see 3.2.6).
(d) Mounting principle to be employed if other than the principle of three point support (see 3.2.6).
(e) Location of main generator power terminals (see 3.2.8).
(f) Quantity and size of cables to be installed between generator terminals and switchboard (see 3.2.10).
(g) Weight, size and configuration (see 3.2.11).
(h) Number of copies of reports covering static and dynamic design analysis if other than specified (see 3.2.12.2).
(i) Whether shock design dynamic analysis is required (see 3.2.12.2.2).
(j) The momentary inclination cycle required (see 3.2.13.1).
(k) Special vibration tests for units (see 3.2.14.2).
(l) The magnitude of internally excited vibration where the specified magnitude does not apply (see 3.2.15).
(m) Special airborne and structureborne noise limitations, whether generator sets are to be resiliently mounted, the procedure for conducting noise tests and special design features not covered (see 3.2.17.2, 3.2.17.2.2 and 4.5.18.2).
(n) When temperature monitoring equipment is not to be furnished by the installing activity (see 3.2.22.4.12).
(o) For the steam turbine and reduction gears (see 3.3):
    (1) Type and class of turbine and gear required.
    (2) Normal rated steam inlet (at throttle) and exhaust conditions.
    (3) Maximum and minimum steam inlet (at throttle) and exhaust conditions.
    (4) Type of governor required.
    (5) Steam rates.

(6) Pressure and temperature of make-up steam for the gland seal system.
(7) Mounting of gageboard, if other than specified in MIL-T-24398.

(p) For the condenser (see 3.4).
(1) Location of thermometers and gages (see 3.4.1).
(2) Maximum auxiliary exhaust steam fan and characteristics (see 3.4.1.1).
(3) Location of connections and whether auxiliary exhaust steam connection is required and location and size of this connection (see 3.4.1.3).

(q) For the air ejector (see 3.5).
(1) Specify type of air ejector assembly (see 3.5.1).
(2) Normal and maximum steam conditions (see 3.5.2).
(3) Whether a gland exhaust fan will be furnished by the activity installing the generator set or whether a gland ejector is to be furnished as part of the air ejector assembly (see 3.5.4).

(r) Where class A, dc generators are required (see 3.6.2.2):
(1) kW rating.
(2) Voltage.
(3) Rpm.

(s) Where class B, ac generators are required (see 3.6.2.3):
(1) Type.
(2) kW rating.
(3) Voltage.
(4) Frequency.
(5) Rpm.

(t) Mounting of balance coils for class A three wire generator sets (see 3.6.3.2).

(u) For voltage regulation and excitation systems:
(1) Whether type II or III is required (see 3.6.4.2.1).
(2) Mounting for type III (see 3.6.4.2.1).
(3) Source and characteristics of initial excitation power if external to generator set (see 3.6.4.2.1).

(v) For governing systems:
(1) Type required (see 3.6.5.1).
(2) Where electric speed and load sensing governors are required, specify the number of control stations in excess of one and the quantity of electric motor operated rheostats to be furnished with load generator set (see 3.6.6.2).

(w) Whether method A or B of MIL-P-15137 applies to repair parts and the number of generator sets to be installed per ship (see 3.11.1).

(x) Quantity, submission date and distribution of preliminary technical manuals (see 3.12.5.2).

(y) Responsibility for preparing final manuals, quantity, date required and distribution of final technical manuals (see 3.12.6).

(z) Drawing list (see 3.13.3).

(aa) Number of preliminary drawings required (see 3.13.4).

(bb) Final drawings (see 3.13.5).

(cc) If parallel operation tests are not required (see 4.5.12).

(dd) The requirements for conducting airborne and structureborne noise tests where special noise reduction features are specified (see 4.5.18.2).

(ee) The units to be tested and the requirements for vibration tests if other than those specified in the individual equipment specifications (see 4.5.20).

(ff) Levels of preservation-packaging and packing required (see 5.2, 5.3, 5.3.1.1.1, 5.3.1.1.1.1, 5.3.1.1.2, 5.3.1.2 and 5.3.3).

(gg) When a flexible reuseable container is required (see 5.2.1.1(b)).

(hh) Special marking required (see 5.4.1).

(ii) Levels of preservation-packaging and packing required for repair parts and special tools (see 5.6).

(jj) When repair parts are to be packed and shipped other than specified (see 5.6.1).

(kk) When polystyrene "loose fill" may be used (see 5.9.1).

6.1.2 Contract data requirements. Data generated by this document are not deliverable unless specified on the Contract Data Requirements List (DD Form 1423) on the contract schedule. The data required by this specification include, but are not restricted to the following:

(a) Manuals (see 3.12).
(b) Drawings (see 3.13).
(c) Test reports (see 4.3.2 and 4.3.2.1).
(d) Packaging technical data (see 5.1.1).

6.2 Definitions. For the purpose of this specification, the definitions specified in 6.2.1 through 6.2.5 are applicable.

6.2.1 Continuous duty. Continuous duty is a service that demands equipment to operate in accordance with the performance requirements of this specification at all loads up to rated value for indefinite periods.

6.2.2 Package (type I) generator set. Package (type I) generator sets are comprised of turbine, turbine accessories, reduction gear (if used), reduction gear accessories (if reduction gear is used), generator, generator exciter (if rotating exciter is furnished) condenser and air ejector mounted on generator set bedplate with associated detached items, as required, such as generator excitation and voltage regulator system.

6.2.3 Nonpackage (type II) generator set. Nonpackage (type II) generator sets are comprised of the same items as the package generator set except that the condenser and air ejector are not included as part of the generator set package.

6.2.4 The definitions for reliability and maintainability of MIL-STD-721 shall apply for the purposes of this specification.

6.2.5 Unit. A unit is defined as an assembly or any combination of parts, subassemblies and assemblies mounted together, normally capable of independent operation in a variety of situations (for example, generator, turbine, reduction gears, condenser, air ejector, pumps, electric motors).

6.3 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.4 The word "NAVSEC" as used herein refers to the Naval Ship Engineering Center (NAVSEC), Steam, Gas and Diesel Generator Section, Prince George's Center, Hyattsville, Maryland 20782).

6.5 Management control system documents. The following management control system documents should be included on DD Form 1660:

(a) MIL-STD-740 (see 3.2.3.1).
(b) MIL-STD-785 (see 3.2.3.1).
(c) MIL-P-15137 (see 3.11.1 and 3.14.2).
(d) MIL-Q-9854 (see 4.2).

6.6 THE MARGINS OF THIS SPECIFICATION ARE MARKED "#" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE WERE MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Preparing activity:
Navy - SH
(Project 6115-N325)

Item	Action	Frequency
1. Turbine generator set	Examine for leaks and loose gear.	Hourly
	Examine for unusual noise.	Hourly
	Observe that vibration is normal.	Hourly
	Examine for loose holddown or foundation bolting.	Quarterly
2. Turbine and reduction gear	Sample and examine lube oil.	Weekly
	Lubricate speed regulating governor linkage.	Weekly
	Operate turbine by steam or turn idle turbine by hand while operating hand lube oil pump.	Weekly
	Operate turbine casing relief valves by hand.	Weekly
	Purify lube oil.	Weekly
	Test overspeed trip by overspeeding generator set.	Monthly
	Clean lube oil sump.	Quarterly
	Test back pressure trip.	Quarterly
	Test lube oil pressure alarm.	Quarterly
	Measure turbine thrust clearance.	Quarterly
	Lubricate flexible couplings.	Quarterly
	Examine pinion and reduction gear.	Quarterly
	Examine high speed flexible coupling.	Semiannually
	Examine condition of all bearings, thrust bearing and journals.	Annually
	Determine bearing clearances.	Annually
	Clean and examine steam strainer.	Annually
	Remove and test turbine atmospheric relief valve.	Annually
	Examine labyrinth packing for wear.	At each regular overhaul
3. Generators (including rotating type exciters)	Examine commutator and slip rings for excessive arcing and brush chatter.	Hourly
	Remove available inspection covers and clean generator interior. Measure insulation resistance.	Weekly
	Examine idle generators for evidence of corrosion and electrolytic action.	Monthly
	Check clearance between bearings and shaft (sleeve bearings only).	Quarterly
	Remove all covers and accomplish thorough cleaning. Check condition and adjustment of brushes and brush-holders. Examine and tighten all electrical connections. Check condition of commutator or slip rings. Measure insulation resistance.	Semiannually

Figure 1 - Planned maintenance actions.

Item	Action	Frequency
4. Static type exciters and voltage regulators	Tighten all electrical connections. Examine wiring, parts and units for evidence of charring or overheating. Check tightness of "heat sinks" for semiconductor devices. Accomplish thorough cleaning.	Semiannually
5. Electric motors	Lubricate oil lubricated bearings.	Monthly
	Lubricate grease lubricated bearings.	As operating conditions require
	Examine for cleaniness and clean, as necessary.	As operating conditions require
	Examine mechanical fastenings and guards.	Quarterly
	Measure insulation resistance.	Quarterly
6. Electric speed and load sensing governors	Tighten all electrical connections. Examine wiring for evidence of charring and overheating. Check tightness of "heat sinks" for semi-conductor devices. Check condition of contact devices. Accomplish thorough cleaning.	Semiannually
7. Air coolers	Examine and clean salt water strainer.	Weekly
	Examine and clean salt water side of cooler.	Monthly
	Examined and clean air side of cooler.	At each regular overhaul
8. Oil coolers	Examine and clean salt water strainer.	Weekly
	Examine and clean salt water side of cooler.	Monthly
	Examine and clean oil side of cooler.	At each regular overhaul
9. Condenser and air ejector	Clean, lubricate and operate all condenser suction and overboard discharge valves.	Weekly
	Examine interior of condenser salt water side. Examine lines where engines are installed.	Monthly
	Lift condenser relief valves by hand.	Monthly
	Test air ejector sentinel relief valves for lifting pressure.	Quarterly
	Examine and clean air ejector steam strainer.	Annually
	Clean steam side of condenser.	At each regular overhaul
	Perform hydrostatic test on steam side of condenser.	At each regular overhaul
	Remove and test the water chest relief valves.	At each regular overhaul

Figure 1 - Planned maintenance actions (continued).

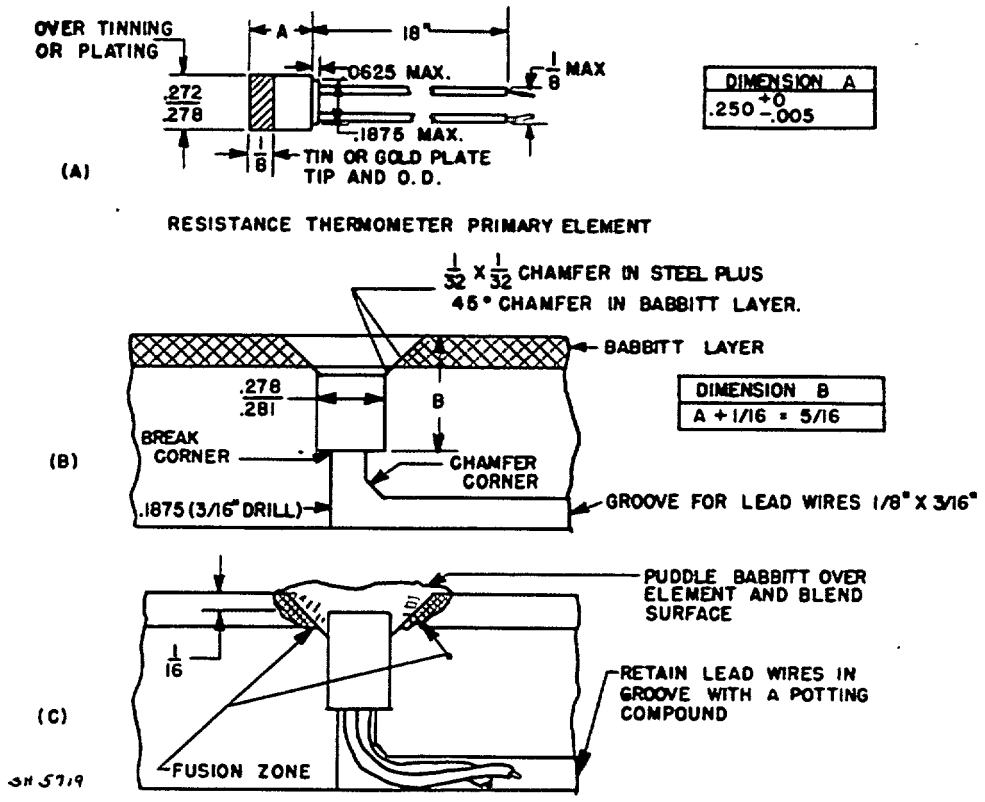


Figure 2 - Typical RTD installation in a bearing.

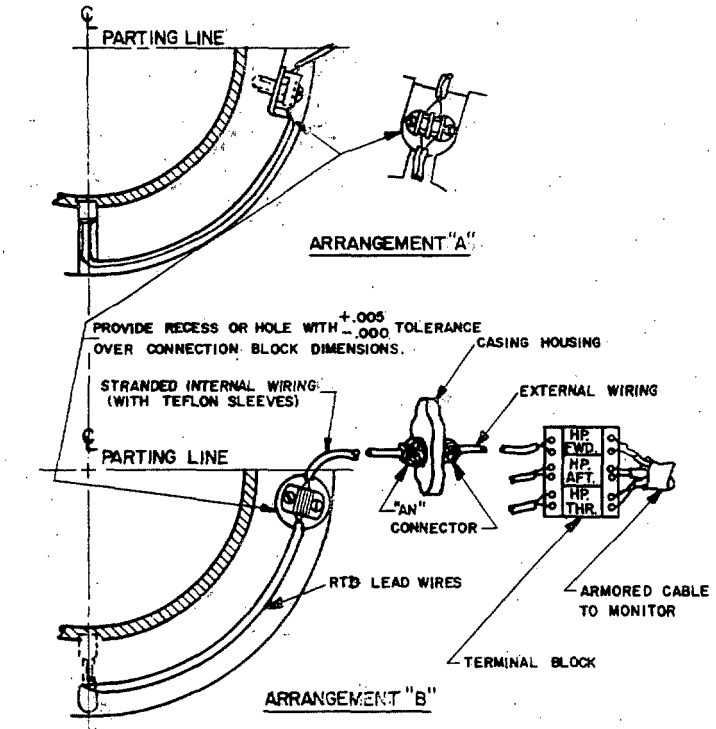
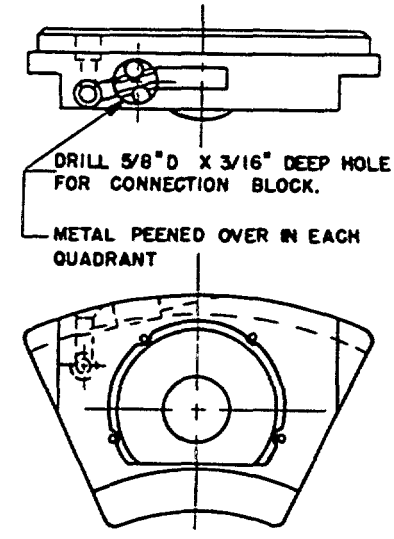


Figure 3 - Suggested RTD installation arrangements in journal bearings.



NOTES

1. RTD INSERTED FROM BABBITTED FACE OF SHOE.
2. CONNECTION BLOCK INSERTED RADIALLY INTO EDGE OF SHOE.
3. RTD LEAD WIRES SHALL BE RUN TO CONNECTION BLOCK THROUGH A DRILLED PASSAGEWAY OR GROOVES ON BACK OR EDGE (OR COMBINATION OF SAME).

SH5121

Figure 4 - Suggested RTD installation in thrust bearing.

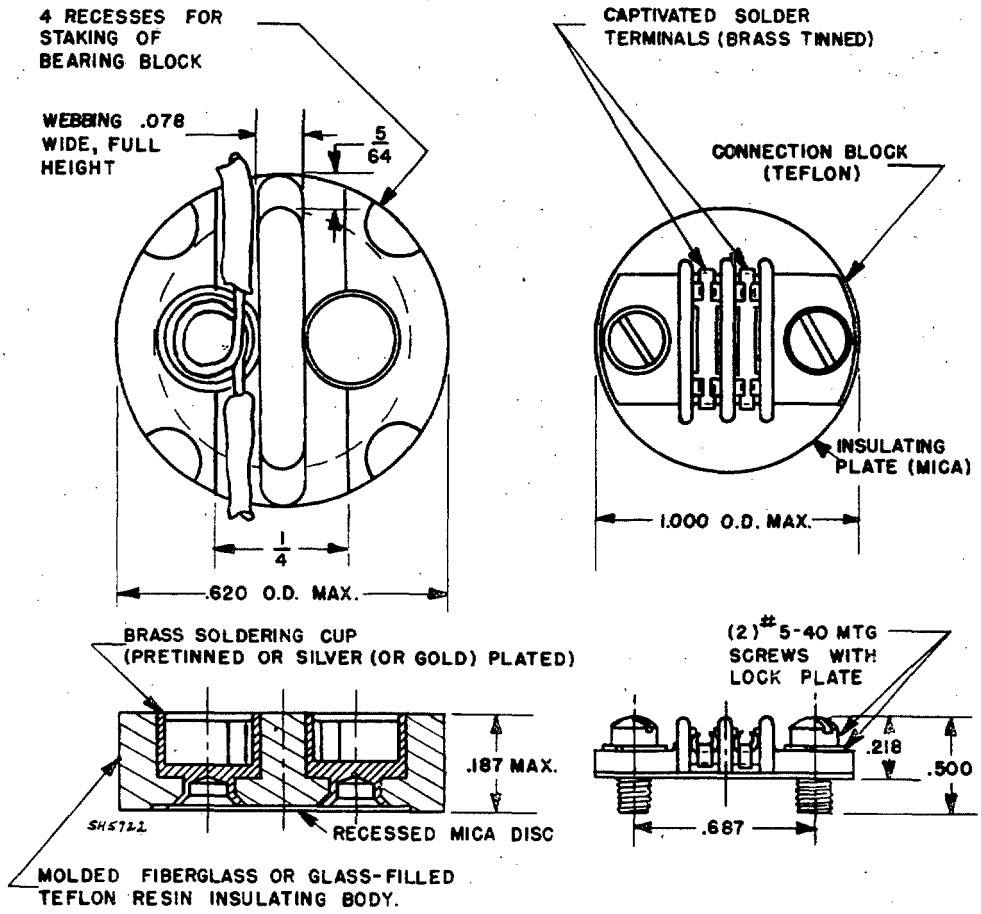


Figure 5 - RTD connection blocks.

1. Equipment _____

2. Identification plate rating _____

3. Service _____

4. Manufacturer: Turbine _____
   Generator _____
   Gear _____
   Condenser _____
   Air ejector _____

5. Place of manufacture: Turbine _____
   Generator _____
   Gear _____
   Condenser _____
   Air ejector _____

6. Model number: Turbine _____ Generator _____ Air ejector _____
   Condenser _____ Gear _____

7. Turbine generator set outline drawing: _____

8. Sectional assembly drawing: Turbine _____
   Air ejector _____
   Generator _____
   Gear _____
   Subbase _____
   Condenser _____

9. Manual number: _____

Figure 6 - Equipment data sheet.

10. Contract or purchase order number: _____

11. Weight:

	Dry	Wet
Turbine	_____	_____
Air ejector	_____	_____
Generator	_____	_____
Gear	_____	_____
Subbase	_____	_____
Condenser	_____	_____
	Total	Total

12. Set overall size: Length_____ Width_____Height_____

13. Height of center of gravity above bottom of condenser_____

14. Applicable ships_____ Number per ship_____

15. Serial number of equipment to be tested: Turbine_____

Air ejector_____

Generator_____

Gear_____

Condenser_____

16. List of detached accessories to be tested with generator set: (List accessory, assembly drawing number, and whether deck or bulkhead mounting)

17. Schedule date(s) delivery to shipbuilder: _____

18. Scheduled test date_____Location_____

Figure 6 - Equipment data sheet (continued).

INDEX

INDEX (continued)

INDEX (continued)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*

TELEPHONE NO.

DATE

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